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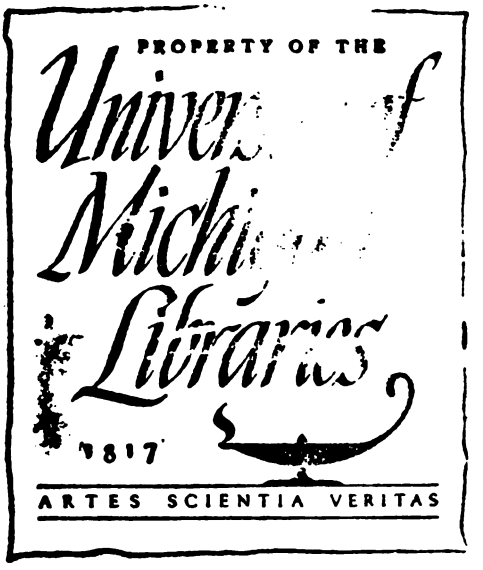
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REPORT

OF THE

METEOROLOGICAL COMMITTEE OF THE ROYAL SOCIETY,

For the Year ending 31st December 1869.

Presented to both Houses of Parliament by Command of Her Majesty.

LONDON:
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PREFACE.

THE Meteorological Committee consists of gentlemen who were nominated in 1866 by the Royal Society, at the request of the Board of Trade, for the purpose of superintending the Meteorological duties formerly undertaken by a Government Department, under the charge of Admiral FitzRoy.

The Committee are credited with a sum of £10,000, voted annually in the Estimates, for the administration of which they are wholly responsible, and over which they are given the entire control.

The Committee hold a meeting of some hours' duration at least once a fortnight, when every subject on which action has to be taken by their executive officers receives their careful consideration. The duties of the Committee are onerous, and *entirely gratuitous;* they were accepted, and are very willingly performed by the members, on account of the earnest desire they severally feel for the improvement of Meteorological Science.

The Committee consists of the following members :—

GENERAL SIR E. SABINE, K.C.B., President of the Royal Society, *Chairman.*

Mr. FRANCIS GALTON.
Mr. GASSIOT.
The HYDROGRAPHER OF THE ADMIRALTY.
Dr. W. A. MILLER.
Mr. DE LA RUE.
Mr. W. SPOTTISWOODE.
Colonel W. J. SMYTHE, R.A.

REPORT

For the Year ending December 31, 1869.

Introductory.

In this their third Annual Report the Committee have the simple task of chronicling the progress effected by the office in the several courses of inquiry, the commencement of which was fully described in the reports for 1867 and 1868.

The most important feature presented by the work of the past year, as compared with its predecessors, has been the organization of systematic operations in the discussion and publication of the results furnished by the self-recording instruments at the observatories. Considerable increase in the computing staff has been requisite to the attainment of this end.

The distribution of duties has been the same as that noticed last year. The whole of the discussions are conducted at the office in London, under the direction of Mr. R. H. Scott; the marine branch being under the special charge of Captain H. Toynbee, the Marine Superintendent.

The general supervision of the self-recording observatories has been hitherto undertaken by Dr. Balfour Stewart, by permission of the Kew Committee of the British Association, in his capacity of Secretary to the Meteorological Committee, and director of the central (Kew) observatory. The Meteorological Committee have to report with sincere regret that Dr. Stewart has found himself unable to continue to devote so much of his time to their service as formerly, and has resigned his office. Such portions of his duties as are connected with the secretaryship, and the relations with the outlying observatories, will devolve upon Mr. Scott. The arrangements which have been made with the Kew Committee respecting the examination of the records from the observatories will be detailed subsequently.

The three heads into which the operations of the Committee are divided are as follows:—

Subdivision of objects of inquiry.

I. *Ocean Meteorology*, comprising the investigation of the meteorological conditions of the entire ocean by means of observations made at sea with instruments lent by the office.

The supply of instruments to the Admiralty is also undertaken by this branch.

II. *Telegraphy and Weather Signals*, comprising the entire system of observation and of telegraphy required for the preparation of the daily weather reports, and for the issue to our own ports and to foreign countries of telegraphic information of ordinary weather and of storms.

III. *Land Meteorology of the British Islands*, comprising the method of inquiry carried on at the seven self-recording observatories established by the Committee. The object of this branch is, firstly, to afford for the entire area of the United Kingdom accurate meteorological information, similar to that published in most European countries under the auspices of their respective governments; and, secondly, to furnish better data for the study of our weather than had previously existed, so as to place the investigations conducted in connexion with Branch II. on a satisfactory scientific basis.

I.—Ocean Meteorology.

tion of ation.

The office continues, as in former years, the practice of lending to captains in the mercantile marine instruments which have been tested at Kew, and are generally, except in short voyages, returned for re-comparison with standards as soon as the ship returns to port. The loan is granted on condition of observations being regularly taken and entered in a meteorological register, which is issued with the instruments, and is sent to the office when they are returned.

The instruments supplied to a ship consist of—

1 Marine barometer (Kew pattern).
6 Thermometers.
1 Thermometer screen.
4 Hydrometers.

And in exceptional cases an azimuth compass is added.

No observations made with instruments which have not been supplied, or authentically verified, by the office are employed in the investigations. Aneroid readings are never used.

Captains of merchant ships are allowed to purchase any of these instruments at cost price, on condition of their keeping a register of observations for the office.

The Committee undertake, in addition to their relations with the mercantile marine, the entire duty of supplying Her Majesty's navy with all the meteorological instruments used in the service. The observations made with these instruments are not necessarily sent to the Meteorological Office, as the keeping of a special meteorological register is entirely voluntary.

ıation of rs.

The direct management of this branch of the office is entrusted to Capt. Toynbee, the Marine Superintendent. The minute examination of the registers as they come in, which is carried out under his directions, has given very satisfactory results. All particulars bearing on the quality of the observations and the mode of taking them, and any answers received from the observers in reply to questions arising out of their logs, are entered on a printed form, and bound up with the register for convenience of reference on future occasions.

The arrears of observations existing in the office are examined on similar principles. The absolute rejection of any registers which bear internal evidence of carelessness, inaccuracy, or "cooking," has been rigorously enforced. In some cases it has

been found that though the instrumental readings were from various causes untrustworthy, the wind and weather observations were of value, and these have accordingly been utilized. The slightest reflection will show the necessity of extreme care in order to avoid spoiling a mass of good observations by the introduction of others of inferior value, whether this be due to the quality of the instruments or to the observer.

The practical effect of the increased attention of the office to the particulars just described has been, as regards the new work, to improve very materially the quality of the registers received during the year.

Discussion of observations.

The efforts of the calculators attached to this branch of the office have been consistently directed to the investigation of the meteorological conditions of the *equatorial* portion of the Atlantic Ocean, as already described in previous reports. The progress effected has been very good, as the Committee have fortunately been able in this, as well as in the other departments, to increase the number of their working staff, so that two additional computers have been engaged. In order to meet the possibility of the calculations being retarded by a deficiency of logs prepared for extraction, Capt. Toynbee has trained two of his most experienced assistants to examine the registers, subject to his control.

Progress of work.

As a general result it may be stated that about half of the materials at present in the office for the district under discussion has been by this time extracted on the plan described in the report for 1867. The very minute examination which the information necessarily undergoes in the process of sifting it into monthly sheets for single degree squares is sufficient to indicate very precise limits for the respective trade wind zones, with the gradual variations in the direction and force of the currents themselves according to latitude and longitude. Equally exact data are afforded for the position of the areas of hot and cold water, which have such an important bearing on the systems of ocean circulation.

Very slight variations in the mean pressure or temperature of the atmosphere are also revealed. It may fairly be augured from the progress already made that the mode of investigation now pursued will be fruitful in results even beyond the expectations of its promoters.

Publication of results.

The question of the future publication of the materials will soon have to be considered. It is obvious that if the mean results, say of the wind, be found to be uniform throughout the hundred sub-squares of a single ten-degree square, no advantage can be derived by proceeding to greater minuteness than a chart or a table for the entire district of 10 deg. of lat. and long. would require.

Issue and return of instruments.

As heretofore, the Committee have not been over-anxious to collect new information, if there was any risk of receiving inaccurate observations. The Marine Superintendent makes a point, if possible, of having a personal interview with the captains of all

ships supplied in London, and he has made several journeys to Liverpool in order to meet the gentlemen, chiefly connected with the great ocean steamship companies who sail from that port. Appendix II. contains a list of the documents received during the year in this department.

When the office was under the management of Admiral FitzRoy, facilities were afforded for captains to receive and return instruments at certain of the ports, such as Liverpool, Bristol, &c. When the Committee took charge of the office, they found that almost all of the so-called "agents" at these ports had been desired by circular to desist from supplying ships. It has now, however, been thought desirable to recommence the practice of employing such agents, and accordingly verified instruments can now be obtained at Liverpool, Hull, Aberdeen, and Dundee.

It is hoped that as the three latter ports are the chief seats of the whaling and sealing trade, information will be obtained from high latitudes in the Atlantic Ocean.

The registers, when received, are divided into four classes: Excellent; Very Good; Good; Ordinary.

itations
tains.

The Committee, wishing to present all gentlemen who have kept "excellent" registers with some slight mark of the value they set on the co-operation of careful observers, have determined to give in each case a presentation copy of the Atlantic Pilot Charts, recently published by the Admiralty. The names of the recipients of these charts during the 15 months ending with March 1870,* are—

Captain's Name.	Ship.
Banner, Frederick William	"Lady of the Lake."
Brooks, Samuel	"City of Brooklyn."
Brown, Robert	"Moravian."
Carruthers, Forrest Priest	"Minero."
Fry, Alfred	"Foam."
†Greenwood, William	"Scotia."
Hayes, James	"Ptolemy."
Henderson, Henry	"Hope."
‡Hodding, Samuel White	"Indus."
Hunter, David	"Alpha."
Jones, Arthur Arundel	"Victoria Nyanza."
Lecky, Squire Thornton Stratford	"Halley."
Martyn, John Artis	"Siberia."
Petrie, Peter Conrad	"Patagonia."
Potts, Thomas Crosby	"Tenasserim."
Rawle, Charles	"Star of the North."
Raymond, Charles Tenzer	"British India."
Smith, William Henry	"Hibernian."
§Stephen, John George	"Moravian."
Watson, William	"Palmyra."
Wherland, Frederick	"Galatea."
Wight, Henry Potts	"Gosforth."

* In addition the Committee have presented barometers to two gentlemen who have formerly kept registers for the office, but have now retired from the sea, viz., to Capt. A. D. Wood in 1867, and to Capt. Isaac Gales in 1870. A set of instruments was also presented to Capt. Alfred Fry in 1868.

† Chief Officer. ‡ Second Officer. § Chief Officer.

Completion of former work of the office.

As in former years, the staff has been employed at extra hours in carrying on the unfinished work found by the Committee in the office when they took charge of it. The progress of these operations was noticed last year, and by the close of 1869 the examination of all the information collected by Admiral FitzRoy for the Pacific Ocean and the China Seas was completed. The results have been forwarded to the Hydrographic Office of the Admiralty for embodiment in their series of physical charts now in process of preparation.

With reference to the wind data for the Atlantic, to which allusion was made in the report for 1868, the Committee have decided not to authorise any publication for the present, owing to a general deficiency of information respecting the less frequented parts of the ocean.

Discussion of anemometrical data for Atlantic.

When these arrears of incomplete investigations relating to the strictly marine branch of the office, and enumerated in the Report of the Committee of Inquiry in 1865, had been cleared off, the subject which appeared in the next instance to demand attention was the reduction of anemometrical data, of which a large collection had been amassed.

At the meeting of the British Association at Dublin in 1857, a committee was appointed " to express to the Board of Trade " the wish of the British Association that self-recording anemo- " meters should be established on some of the islands in the " Atlantic Ocean, in aid of the meteorological observations now " being carried on on shipboard under the direction of the " Meteorological Department of the Board of Trade." The result was, that three anemometers on Dr. Robinson's pattern were erected early in 1859; two of them, those at Bermuda and Halifax, at the expense of the Meteorological Department, while the cost of the third, which was placed at Ascension, was mainly defrayed by the Government Grant Committee of the Royal Society.

The instrument at Bermuda has been in almost constant action since that date. That at Halifax was taken down in 1862, and removed to Sandwick Manse, near Stromness, where it remained at work under the superintendence of the Rev. C. Clouston, LL.D., up to June 1869, when it was replaced by a new instrument. The anemometer set up at Ascension was brought home when Lieut. Rokeby left that station in 1865.

The records furnished by these instruments have been only partially discussed. Reductions of the anemograms for 18 months from Bermuda, and for two years from Halifax, were effected in the office, and published respectively in the 8th and 13th numbers of Meteorological Papers. Some portion of the records from Sandwick Manse have been tabulated, and the observations at Ascension were discussed by Lieut. Rokeby.

No systematic treatment of the materials on the principles recommended by Dr. Robinson had ever been undertaken. It

was therefore determined by the Committee to commence the tabulation, reduction, and discussion of this accumulation of important matter. The work is now in progress, but will require a considerable time for its completion. It will be observed that all these special inquiries are totally distinct from the ordinary work of the office, with which no interference is permitted. The cost of the extra work is defrayed from time to time by special grants made by the Committee, who hope gradually in this way to be able to overtake the arrears of work in the office, and to give the results to the public.

eters. In the last report reference was made to the improvement of deep-sea thermometers: the construction of these instruments has been much improved in the course of the year. The Committee appointed by the Royal Society to superintend the dredging expedition conducted by Dr. Carpenter, Mr. J. Gwyn Jeffreys, and Dr. Wyville Thomson, in H.M.S. "Porcupine," have, at the suggestion of Dr. W. A. Miller, adopted a form of thermometer for deep soundings which resembles in principle that formerly employed under Admiral FitzRoy's direction, and described in Meteorological Papers, No. I., p. 55. Dr. Miller's instrument is fully described in the proceedings of the Royal Society, Vol. XVII., p. 482, from which the notice in Part II., p. 25, is extracted. The chief points in which it differs from its predecessors are its being of much smaller size, and therefore more convenient, and the fact that the liquid contained in the interval between the external glass casing and the actual thermometer bulb is spirit instead of mercury.

Great care is taken to prove every instrument thoroughly before it is issued, and they are all tested in a hydraulic press, the force exerted being gradually increased up to 2½ or 3 tons per square inch so as to obviate any risk of the thermometers breaking from sheer pressure on service, and to ascertain the corrections to be applied to their readings for any given depth of water. These thermometers have given great satisfaction, one of them having been used throughout the entire cruise without its accuracy being in the slightest degree impaired.

These deep-sea thermometers are kept for the exclusive use of the Hydrographic Department of the Admiralty.

nts: ty In Appendix III. will be found a list of all the instruments supplied to ships in the Royal Navy during the year, with a statement of the entire stock of instruments standing on the books to the account of the Admiralty on the 31st December 1869. This latter statement is prepared from the latest returns furnished by the respective storekeepers at the dockyards, &c.

The work of tracing missing instruments has been systematically carried on during the year, and many questions relating to their disposal have been cleared up.

nts: Trade Appendix IV. gives similar information with regard to the Board of Trade instruments.

These tables, when compared with those for last year, show a considerable reduction in the number of instruments belonging to both accounts in use on shore. This amounts in—

——	Barometers.	Aneroids.	Thermometers.
Admiralty account -	10	20	36
Board of Trade account -	7	Compasses. 2	30

All these instruments have been recovered for use at sea.

The increase of heavy guns in the navy has brought with it an increasing demand for the so-called "gun" barometers which were made under Admiral FitzRoy's direction, and specially adapted to resist concussion, by surrounding the tube with thick india-rubber tubing. These instruments were formerly only graduated to 0.01 inch, but as the tubes and the rest of the instruments were made with as much care as other barometers, the scales are now being graduated to thousandths of an inch, soas to render the instrument capable of as accurate reading as one of the well-known Kew pattern marine barometers.

Supply of instruments to navigation schools.

Instruments have been supplied by the Committee for educational purposes to the following navigation schools:—

Aberdeen - - -	Master, Mr. Jones.
Leith - - -	„ Mr. J. Bolam, jun.
Plymouth - - -	„ Mr. J. Merrifield.
South Shields, the Winter-bottom Marine School -	„ Rev. Dr. Hooppell.

In addition a set has been allowed, with the special sanction of the Board of Trade, to remain at the Church of Scotland Training School in Edinburgh.

Other instruments not used in the immediate service of the office have been recalled, with the exception of the supply presented to the Scottish Meteorological Society, as noticed in the last report.

II.—Telegraphy and Weather Warnings.

Position of stations.

The only material change which has taken place in respect of the telegraphic system in the course of the year has been an increase in the number of reporting stations both at home and abroad. The list of these points of observation in our islands, with the respective observers' names, will be found in App. V. Their number is now 20 (including London, where the reports are made by the clerks in the Meteorological Office), and they are situated, eight in England, two in Wales, six in Scotland, and four in Ireland. The substitution of St. Ann's Head, at the entrance of Milford Haven, for Weymouth has been a most useful change The development of telegraphic communication

with the extreme north of Scotland has rendered it possible to receive daily reports from Wick and Thurso, and these stations have therefore been established, the former in the month of September, the latter at the beginning of February 1870. This extension of the system has proved to be of much practical benefit. Nairn was formerly the most northerly of the stations, and although it is on the coast, and has a very level country in its immediate neighbourhood, it is so enclosed on the S., W., and N.W. by a mountainous country that the most violent storms from the quarters indicated are rarely felt there. The reports from the two additional stations, which are situated at a considerable distance from any mountains, and possess a very good exposure to the winds, have enabled the office to form a much more correct conception of the conditions of weather prevailing daily on the north coast of Scotland than was previously possible. Some of the other stations, especially Liverpool and Greencastle, are at least as disadvantageously situated as Nairn. As regards Liverpool, the Committee are encouraged, by the readiness with which the authorities connected with the observatory belonging to the Mersey Dock Board have consented to co-operate with them, to cherish the hope that as soon as direct telegraphic communication with Birkenhead has been properly organized they will be able to receive daily reports from that observatory, which is situated in a well-exposed position on Bidston Hill near Birkenhead. The question of improving the reports from Greencastle presents serious difficulties. The N.W. coast of Ireland is so mountainous that it is almost impossible to find an unexceptionable place for wind observations. The same obstacle meets the proposal to obtain reports from the coast of the western highlands of Scotland.*

All the stations were visited by Mr. Scott in the course of the year, and were found to be almost uniformly in very good condition.

In order to test thoroughly the daily weather reports, comparisons have been instituted between the daily observations registered at the telegraphic stations, and the information for the same hours collected from the continuous curves at the observatories. This has only been possible in a few cases where the telegraphic station was reasonably near an observatory; thus Ardrossan was compared with Glasgow, London with Kew; and the results, as regards the correctness of the instrumental readings reported daily, have been very satisfactory.†

* The Committee have resolved, in compliance with a desire which has been very generally expressed, to replace Dover on their list of stations, so as to provide daily information from the S.E. coast of England. Dover with five other stations had been suppressed when the number of stations was reduced at the end of December 1864.

† The transference of the telegraphs over the United Kingdom to the Post Office which took place on the 5th of February will probably occasion some modification in the arrangements previously existing for the supply of the daily reports. However, from the great care which Mr. Scudamore, on behalf of the Post Office, has taken to ensure the speedy and accurate transmission of their telegrams, the Committee have every reason to expect that the change will be in every way beneficial to the cause of meteorological telegraphy.

A considerable change has taken place in respect of the interchange of weather reports with foreign countries, owing to the establishment of direct communication with Norway and Holland. The Meteorological Office now receives from the Observatoire Impérial in Paris reports from Paris (twice daily), as well as once a day from Strasbourg, Lyons, Brussels, and Corunna. The Ministère de la Marine forwards reports from Cape Grisnez, St. Mathieu (Brest), Grognon (L'Orient), Ile d'Aix (Rochefort) (twice daily), Biarritz, and Cape Sicié (Toulon).* In return, the Meteorological Office sends to the Observatoire reports from Nairn, Scarborough, Yarmouth, Penzance, Valencia, and Greencastle, (from the two last twice daily), and to the Ministère de la Marine a daily résumé of the weather as reported from the stations in these islands and in Norway. Telegraphy with the continent.

The daily report from Helder, formerly received viâ Paris, now comes direct to London from Holland.

It is, however, with regard to Norway that the system has undergone the most extensive modifications. In the course of last summer a direct cable was laid from Peterhead to Egersund on the coast of Norway, and in the month of October Professor Mohn, director of the Royal Meteorological Institute of Norway at Christiania, submitted to the Committee a proposal for a daily interchange of observations, which was carried into effect in the first days of December. The arrangements are, that the Meteorological Office receives from Norway daily reports from Christiansund, Skudesnaes (twice a day), and from the island of Oxö near Christiansand, and sends in return information from Nairn (twice a day), Yarmouth, and Valencia.

It will be seen from the foregoing that the office receives 35 reports every morning and 9 every afternoon. The stations are situated along the entire coast of the continent from Christiansund in lat. 63° N. to Corunna, with the exception of the coast of North Germany, and of Denmark. It is, however, hoped that ere long intelligence may be regularly received from these districts also. Extent of the system.

Experience has shown that in most instances the office is able to transmit to neighbouring countries information of much greater value than any which it can receive from the continent, owing to the fact that most of our storms come to us from the Atlantic.

The service with Heart's Content has been maintained during the year owing to the continued liberality of the directors of the Anglo-American Telegraph Company. The messages are transmitted *free of cost* over the ocean wires to Valencia, so that the cost to the Committee of this distant station is precisely the same as if it were on the coast of Ireland. Heart's Content.

* These latter stations have all been placed (March 1870) in connexion with the observatory of Montsouris, established in the course of the year 1869, and managed by a meteorological commission of which M. C. Ste. Claire Deville is president.

Preparation of daily weather report.

The daily observations, with the exception of those at Heart's Content, are taken at 8 a.m., Greenwich time, and most of the telegrams arrive in London at about 10 o'clock. An hour is required for their reduction, discussion, and the preparation of the daily weather report, copies of which are at once supplied for the afternoon issue of several of the London papers. A brief telegraphic résumé of the weather is despatched to the Marine Ministry in Paris, and if necessary, telegraphic intelligence of storms or of atmospherical disturbance is sent to our own coasts and to foreign countries. Later in the day the foreign telegrams, and subsequently the afternoon reports, come in. Copies of the complete report are then sent by post to the newspapers for next day's morning issue, and to certain seaports which have applied for it on the terms named in the circular issued by the Committee in March 1867. (See Report, 1867, p. 17.) In addition, copies are supplied to a few meteorologists at a cost slightly exceeding the expense of postage. The list of recipients is contained in App. VI.

Telegraphic weather intelligence.

The intelligence of storms which is sent out from the office is of different characters, according to the requirements of the place which receives it. In App. VII. will be found a list of the stations which are furnished with drums, in accordance with circular 278 of the Board of Trade, issued in December 1867 (App. VIII.). These stations are 106 in number, and are situated, 55 in England, 13 in Wales, 26 in Scotland, 10 in Ireland, and 2 in Jersey. Lamps for night use are supplied to a few of the stations. All the stations have been established and are carried on on the terms laid down in the circular, excepting the dockyards, which are of course under Admiralty management. The messages sent consist of an order to hoist the drum, accompanied by a brief explanation of the reasons why it is to be hoisted. The message is posted up as soon as it is received, for the information of the public. It continues in force for 36 hours, *and no longer*, from the time of its receipt, unless modified by a subsequent telegram, which is frequently sent, either when the danger is known to have passed over, or when there are signs of the approach of another storm.

The experimental semaphores which have been on trial at Blackwall, Liverpool, and Tynemouth, have been taken down, as it was found that the drum signal was sufficient for the requirements of the respective ports, as far as they could be ascertained.

Telegraphy to Liverpool.

In addition to the foregoing, a special telegram is sent to the Underwriters' Association of Liverpool, whenever the difference between any two barometrical readings taken that morning in these islands or on the adjacent French coast, exceeds half an inch. The message consists of reports of the atmospherical pressure and the wind at three or four stations. By this means intelligence of the general conditions of weather that morning reaches the underwriters' rooms daily before 1 o'clock, as long as the atmosphere continues in a disturbed condition. Half the

expense of transmission of these telegrams is borne by the Association.

The intelligence of storms sent to foreign countries differs in each special case. To France* the same messages are sent as to our own south coast and to Jersey. A telegram is despatched to Utrecht and Hamburg, whenever the difference of readings between any two of our stations exceeds 0·8 in., and the authorities at Hamburg hoist drums at that port and at Cuxhaven whenever the intelligence received justifies the step in their opinion. The practical value of this information to the trade of Hamburg has been even more striking in the course of last year than it was before. In the Second Annual Report of the Norddeutsche Seewarte, Herr von Freeden says,— Warnings to the continent.

"Let us now turn to the English storm warnings, for which "we are indebted to the courtesy of the Meteorological Office in "London.

"We have received altogether 48 telegrams during the year "1869. Of these 18 were simply cautionary, as to the more or "less threatening state of affairs, and out of these, four expressly "stated, 'Do not hoist yet.'"

"The 30 remaining telegrams may be considered as real storm "warnings, but the direct order to hoist the 'drum' signal was "only given in 22 cases.

"Then the storm was experienced (a storm being taken as at "least 30 miles per hour)—

"Same evening, or next day	- -	13 times
"Previous day	- - - -	4 „
"(In three of these cases a Sunday had inter-		
"vened and no telegram could be sent.)		
"Squally weather	- - - -	6 „
"Fine „	- - - -	7 „
"Total	- - -	30 „

"In two cases we received no telegram, but in one instance, "as is clearly stated, it was owing to an interruption on the "wires."

The issue of warnings is conducted strictly according to the method indicated in the last report, and it is gradually assuming a more scientific character, according as principles which seem Weather study and issue of warning.

* Since the commencement of the present year 1870 the Committee have been requested by the Ministère de la Marine to issue warnings for the *entire* north and west coast of France. They have declined to undertake so great a charge, but have consented, whenever it seems requisite, to send telegrams to Paris for transmission to the ports situated on the coast from Dunkerque to Nantes. At these stations the drum is hoisted, and it has precisely the same signification as in England.

The Norwegian government are also adopting the drum, and it is hoisted at Oxö near Christiansand.

to regulate the changes and sequence of our weather appear to be revealing themselves.

The Committee in the increase of their computing staff, to which allusion has already been made, have added two to the number engaged in this department, and the results have been very satisfactory. The daily weather chart is drawn regularly, and in addition an abstract of the conditions of weather for each day is entered in a book and carefully analysed. The books are in monthly volumes and each of them is copiously indexed, so as to afford facilities for the recognition of recurring types of weather.

Exchange of daily bulletins.

In order to supplement the telegraphic reports the office keeps itself in constant correspondence with the principal meteorological organizations of the continent, and exchanges the lithographed daily weather reports for their respective bulletins. The institutions with which such an interchange is maintained are given in the note.*

Increase of number of stations.

Each case of issue of a warning message is specially investigated with respect to the weather recorded at the self-recording observatories and the telegraph stations. As these points of observation are rather sparsely scattered around our coasts measures are being taken by the Committee to increase the number of their automatic instruments by erecting anemometers at Holyhead and Yarmouth (see p. 22), and to invite co-operation from private observers. In the last-named direction they have received great encouragement, as not only have several gentlemen of great zeal and acknowledged accuracy in observing agreed to help them by furnishing reports of wind and weather, but in some cases even daily anemographical records have been promised them.† This plan was only commenced at the close of the year, so that it would be premature to speak of it at more length.

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* List of Daily Meteorological Bulletins received at the Meteorological Office.

Place.	Whence issued.
Christiania - - -	Norske Meteorologiske Institut.
Hamburg - -	Nord-deutsche Seewarte.
Lisbon - - -	Observatorio do Infante D. Luiz.
Paris - - -	Observatoire Impérial.
Paris - - -	Observatoire Météorologique Central de Montsouris.
St. Petersburg - -	Observatoire Central Physique de Russie.
Utrecht - - -	Koninklijk Nederlandsch Meteorologisch Instituut.
Vienna - - -	K. K. Central-Anstalt für Meteorologie und Erdmagnetismus.

† Records of this nature have been received from His Grace the Duke of Northumberland, Alnwick Castle; R. H. Barnes, Esq., Bayswater; Rev. F. W. Stow, Whitby.

The principle that the direction and force of the wind on any day depend on the amount of difference in barometrical readings over a given area, or on the "gradient," as explained in the last report, has proved itself to be thoroughly trustworthy. The problem in weather study to which attention must now be directed is the discovery of the probable path of each storm taken as a whole, and of its rate of progress across the country. This is a question most difficult of solution, but great light is and will be thrown upon it by the study of the continuous records furnished by the observatories. At this point, therefore, the labours of the two branches of telegraphy and land meteorology coalesce. Under the latter head at p. 21 will be found an account of the proposed Quarterly Weather Report. This current chronicle taken with the facsimile representations of the graphical instrumental records, will afford materials for subsequent weather study incomparably more copious and accurate than anything which has been hitherto available either in this country or elsewhere.

Non-official publications.

In addition to the work which has just been described, inquiries of a more theoretical character have been carried out during the year. The Committee, considering that speculative deductions of the nature indicated should rest on the authority of the respective investigators, have sanctioned the commencement of a series of non-official papers, consisting of reports addressed to them on the several questions which have been the subjects of the inquiries. The authors of these reports are alone responsible for their contents. The first paper of this class was Mr. Scott's "Report on the Connexion between Strong Winds and Barometrical Differences," noticed in the last report. It has been followed by two others from the pen of Capt. H. Toynbee, of which the first is "On the Meteorology of the North Atlantic between the parallels of 40° and 50° N.," the other "On the Use of Isobaric Curves." The former of these is an examination of the observations taken on board the Atlantic mail steamers on their outward and homeward voyages. Four passages each way, made by one observer, Capt. John A. Martyn, have been taken, and the diagrams of the observations exhibit this remarkable peculiarity, that when the ship is *outward* bound, the barometrical and thermometrical curves are marked by frequent oscillations, and the wind usually shifts from S. to W. and back again several times during the passage; while when she is *homeward* bound the instruments and the wind are much more steady. Capt. Toynbee offers as an explanation of these facts the idea that the atmosphere over the Atlantic is in a state of constant motion in a direction which is generally easterly, and at a rate of progress slightly less than that of a full-powered steamer, and that it is disposed in a series of successive eddies or waves. The ship, when outward bound, meets and passes through several of these systems, while on her homeward passage she may run with one for days together, and so experience little

Meteorology of the North Atlantic.

change either in wind or weather. It is almost unnecessary to say that should these views be confirmed by more ample experience, the generalization is calculated to be a most useful one, as well to scientific meteorology as to practical navigation.

The use of isobaric curves.

Captain Toynbee's Second Report is on the use of isobaric curves, in affording a clue to the present and probable conditions of weather. He has investigated the weather charts for several days at various seasons, drawing on every chart two lines, one indicating the line of greatest actual barometrical gradient as shown by the observations, the other showing the greatest change in the distribution of pressure, and joining the station where the barometer has risen most rapidly during the preceding 24 hours with that where the fall has been greatest. The normal to the first of these lines shows, on the principle of Buys Ballot's law, the wind which will prevail during the day, while the normal to the second indicates the probable change in direction and force which will supervene in that wind. It is evident that if these two lines run in the same direction the wind will increase, and *vice versâ*, it will die down if their directions be opposed to each other.

These results are very useful, and they are employed by the office in the issue of cautionary telegraphic warnings.

Another practical principle which is brought under the notice of seamen in this report is, that the tack on which a ship is sailing influences the rate of rise or fall of the barometer on board.

Fishery barometers.

The Committee have continued the practice of lending barometers to small ports and fishing stations, where the inhabitants are too poor to be able to provide such an instrument for themselves. The barometers usually supplied are the so-called "Fishery Barometers," which are of large size, so as to be easily consulted, and yet of considerable accuracy. This form of instrument was originally devised at Admiral FitzRoy's suggestion. 14 of these barometers were issued on loan during the year, and there are now 111 stations round our coasts supplied with barometers for public use.* The stations are situated, 48 in England, 2 in Wales, 39 in Scotland, and 22 in Ireland, see App. IX. The Board of Fisheries in Edinburgh has kindly undertaken the local supervision of these instruments in Scotland, and no fresh grants to Scotch stations are made without consultation with that office.

III.—Land Meteorology of the British Islands.

Stations.

It is in respect of this branch of their system that the operations of the Committee have undergone the most active development since the date of the last report. The stations fitted with self-recording instruments are seven in number, and they were

* The Royal National Lifeboat Institution has also erected several of these instruments on the coast.

all inspected by Dr. Stewart in the course of the year. The following particulars about them may be of interest:—

Observatory.	Superintended by	Latitude N.	Longitude W.	Height of Barograph Cistern above Sea Level.
		° ′	° ′	Ft.
Aberdeen	D. Thomson, M.A., Professor of Natural Philosophy.	57 8	2 5	88·5
Glasgow	R. Grant, LL.D., F.R.S., Professor of Practical Astronomy.	55 51	4 16	184
Armagh	Rev. T. Romney Robinson, D.D., F.R.S., Astronomer.	54 22	6 39	207·3
Valencia	Rev. Thos. Kerr	51 54	10 25	23·0
Stonyhurst	Council of Stonyhurst College.	53 50	2 25	360·7
Kew	Kew Committee of British Association.	51 29	0 18	34
Falmouth	Royal Cornwall Polytechnic Society.	50 9	5 4	210·8

The records from all the observatories are examined at Kew, in accordance with the regulations contained in Part II. of the report for 1868, prior to being sent to the office in London for discussion.

New arrangements with Kew.

Dr. Balfour Stewart having resigned his appointment as secretary, the arrangement heretofore existing between the Meteorological Office and the Kew Committee has (with the concurrence of the Council of the British Association) been settled *pro tem.*, on the following conditions:—

The records from the outlying observatories, together with those of the central (Kew), are, as heretofore, to be examined at Kew, in consideration of an annual sum (400*l.*) being allowed for the performance of that duty. This payment is irrespective of the annual grant (250*l.*) made to Kew as one of the seven self-recording observatories, and is an increase of 200*l.* on the amount originally paid to the Kew Committee for the same work, while the special salary to Dr. Stewart, as secretary, is no longer payable.

The direct supervision of the observatories is, from the commencement of the present financial year, to be transferred to the Meteorological Office.

It is understood that these arrangements shall continue in force as long as the present position of Kew Observatory with the British Association remains unchanged.

The Meteorological Committee regret that they have not been able to retain the benefit of Dr. Stewart's continued assistance to the same extent as in former years. They desire to record and acknowledge that they fully recognise the practical experience and the eminent scientific attainments of that gentleman, as evinced by him during their arduous task of arranging and

finally establishing a new and delicate system of meteorological observations.

Utilization of results.

The Committee, finding that at the end of 1868 the difficulties of first starting the system had been overcome, and that the various observatories were sending in their records with great regularity and comparative freedom from defects, resolved that their systematic publication of results should commence with the year 1869. They have therefore during the year increased their computing staff, so as to keep pace with the progress of the instruments. The continuous records will be capable of being utilized for entirely distinct purposes. On the one hand, they will undoubtedly furnish mean numerical results of accuracy surpassing anything which could be yielded by eye observations; and on the other hand, they will exhibit the changes in atmospherical conditions which pass over our islands with absolute fidelity, and will thereby throw a totally new light on the study of weather.

The appendix to the last report contained specimens of tables of average results which were in process of calculation. These have been completed for the year 1869, and are in type: they are two in number.

Description of Tables.

Table I. gives the monthly means for the barometer and dry thermometer, with the extreme readings, maximum and minimum, for each month, and in addition the monthly means of vapour pressure and of dry air.

Table II. gives the five-day means of the barometer and the dry and wet thermometers.

Periodic corrections.

These tables will at the end of five years be supplemented by a third, exhibiting the hourly periodic corrections of temperature, so as to afford data for the determination of daily range in all parts of the country.

Anemometrical reductions.

The calculation of numerical average results for the wind presents very serious difficulties, owing to the extremely changeable nature of our climate. It has finally been decided at the instance of Dr. Robinson, whose authority on the subject of anemometry is unquestioned, to conduct the discussion with a view to occasional publication at definite intervals, inasmuch as it appears that five years is the shortest period from which results of any practical value could be expected.

Publication of curves.

Lastly must be noticed the method adopted by the Committee for presenting their continuous records to the public in a form available for weather study. In the last report the issue of lithographed curves, at full size, obtained by tracing from the originals and the subsequent use of the anastatic process, was mentioned. It became evident that any reproduction of the records at natural size would be far too cumbrous and costly. A little consideration showed that the time scale would bear much greater reduction than that of the ordinates for the actual instrumental readings. The problem which then presented itself was how to reproduce the curves by instrumental means with entire truthfulness, at the same time varying their scale in the manner

indicated. This difficulty has been met in the most satisfactory manner by one of the Committee, Mr. Francis Galton, who has invented a pantagraph which effects all that is required of it in this direction with the utmost accuracy, and is at the same time very easy of manipulation. A description of the instrument will be found in Part II. at p. 32.

The zinc templates obtained from it exhibit the curves on the same vertical scale as the original, but with the horizontal scale reduced to one third. These templates are then capable of any further reduction which may be desired in the ordinary pantagraph. The amount of reduction which has been adopted is one half, so that the final curves published are on one half the vertical and one sixth the horizontal scale of the original curves obtained from the instruments themselves.

It is found that when the records are reduced in this proportion the entire information from the barometers and thermometers at the seven observatories for five days can be brought within the space of a 4to. page. The data for wind and rain for the same interval form a corresponding plate.

It is obviously of paramount importance that the most extreme mechanical precision should be provided, so that the records shall be capable of exact measurement at any epoch of time.

The ordinary pantagraph is not sufficiently accurate for such very delicate work. The Committee have therefore ordered one of the pantagraphs invented by F. Wagner, junior, of Berlin. The construction of these instruments is admittedly superior to that of any others in use. This instrument will be ready about the month of June.

In order to avoid additional delay it has been determined to reproduce the records for the first three months of 1869 by lithography, and the work has been entrusted to Malby & Co. Specimens of the lithographed plates produced by the method above described are given (Plates I. and II.) representing the weather from Jan. 26–30, 1869.

The curves will, however, require some explanation, and with the view of affording this the Committee have directed that a continuous chronicle of the weather should be prepared. This has been commenced, and it is based on the data furnished by the observatories, combined with that provided by the telegraphic weather reports, ships' logs, and other sources of accurate information, such as observations made by independent British observers of known accuracy, and by the several bulletins, &c., published abroad (p. 16).

Quarterly Weather Report.

This chronicle will be illustrated by small sketch charts showing the conditions of barometrical pressure and of wind whenever such information seems requisite. This weather journal with the plates of curves will appear at intervals of three months, and will be entitled the Quarterly Weather Report of the Meteorological Office. With this publication the mean numerical results will be from time to time issued.

Additional stations.

On commencing the systematic study of weather it at once became evident that additional information was required from British stations in order to afford an accurate insight into the changes of our weather. The most obvious particular in which an increase of points of observation was required was the wind. A cursory inspection of the simultaneous anemometrical records from the existing observatories was sufficient to show that their indications were much influenced by local conditions, the inland stations showing much less wind than those exposed to the sea. In order to obviate partially the inconvenience arising from this cause three new anemometers have been erected during the year at exposed points on our coasts. One was erected in June at Sandwick Manse, Orkney, in order to replace the instrument which has been in action there for the last seven years under the superintendence of Dr. Clouston. The second has been placed at Holyhead, and the third at Yarmouth. At the former station the anemometer is placed on the top of the old lighthouse by permission of the Board of Trade. The Committee have also to acknowledge the valuable assistance which they have received in the matter from Rear-Admiral Schomberg, the harbour master. At Yarmouth the instrument is set up on the Sailors' Home with the sanction of the committee of that institution.

The other measures which are being adopted with the view of inviting volunteer co-operation in observations have already been detailed (p. 16).

Self-recording rain gauges.

An important development of the automatic system of observation introduced by the Committee will take place in the course of the year 1870, as they have determined to erect self-recording rain gauges at all the observatories. The form of instrument adopted is that invented by Mr. Beckley, a description of which will be found in Part II. (p. 36).

Expenditure.

Change of office.

On closing their accounts for the financial year 1868–9, the Committee fortunately found themselves with a balance to their credit, so that they were in a position to meet the serious outlay entailed on them by the necessity of fitting up and furnishing a new office. The total expenditure on this head has exceeded 750*l.*

It was at the end of February that notice was received from the Board of Works that they desired to resume possession of the rooms at No. 1, Parliament Street, which had been in the occupation of the Meteorological Office since its establishment. The Committee succeeded in finding suitable accommodation in the house No. 116, Victoria Street, and the office was removed to its present location on the 31st of May.

The addition to its annual expenditure entailed on the office by this change has been very considerable, exceeding 370*l.*, for rent, &c., which is further increased by charges for firing, light, cleaning, and the wages of an office keeper.

Another source of augmented outlay has been the increase in the computing staff, in order to cope with the arrears of observations already existing in the office and the materials constantly coming in. The necessity of action in this direction was most emphatically urged by the Committee of Inquiry in their report, and the Meteorological Committee have kept constantly before them the desirability of carrying it out. Increase of staff.

No fewer than nine new computers have been engaged at weekly wages. Of these, two are attached to the branch of ocean meteorology, two to that of telegraphy, four to that of land meteorology of the British islands, while the ninth gives assistance in the clerical work of the accounts and correspondence. The payment of these gentlemen entails a yearly charge exceeding 500*l.*

The Committee are glad to be able to say that notwithstanding this great permanent increase of their expenditure they have been able to confine it within the limits of their annual grant. They find themselves at present with a balance of 1,486*l.* at their bankers, but of this sum almost the whole has been anticipated by various contracts, &c. The postal telegraph accounts for February and March will not fall much short of 300*l.*; 230*l.* is required to defray outstanding accounts for instruments for the mercantile marine; the pantagraphs will cost 280*l.*; and the rain gauges 210*l.* On the whole the Committee will commence the year 1869-70 with a small available balance in hand, and they hope, by careful management, to succeed in discharging the duties they have undertaken without requiring a present increase in the grant allotted to them by Parliament. In Appendix X. will be found a list of the present staff in the employment of the Committee, and of their several occupations. Present position.

App. XI. gives a list of the additions to the library made during the year. These books have, for the most part, been received in exchange for the publications of the office.

Summary.

The progress made in the office during the year in the various directions of its inquiries may be thus summed up:—

I. *Ocean Meteorology.*—The investigation of the meteorology of the equatorial portion of the Atlantic Ocean has made satisfactory progress, as the number of assistants engaged on it has been increased.

The unfinished discussions relating to the Pacific Ocean, found in the office, have been completed, and the results sent to the Admiralty for embodiment in their series of physical charts.

The work now in hands at extra hours is the reduction of anemometrical data.

The issue of instruments on loan has been continued, and the character of the registers received shows a very sensible general improvement. The Committee have presented copies of the

Atlantic pilot charts to certain captains, who have kept "excellent" logs. Their names will be found at page 8.

The cost of this department has been 1,639*l.* 1*s.* 6*d.*

II. *Telegraphy and Weather Warnings.*—The home-reporting stations have been increased by two, Wick and Thurso. No material change has been made in the system of telegraphy with France, but a regular interchange of reports has been instituted with Norway, which has been productive of much mutual benefit.

The drum signal is hoisted, on orders from the Meteorological Office, at 106 British stations, as well as along the coast of France from Dunkerque to Nantes.

The study of weather is conducted on systematic principles; every warning message issued is carefully compared with the subsequent weather experienced as recorded at the self-recording observatories.

Fourteen new fishery barometers were supplied during the year, making the total number round our coasts 111.

The cost of these operations has been 2,639*l.* 0*s.* 1*d.*

III. *Land Meteorology of the British Islands.*—The regular discussion of the observatory records has been undertaken, and the mean results for the year 1869 are in type. Measures have been adopted to reproduce the curves yielded by the instruments in facsimile, so as to present to the public the entire information obtained by the system.

It has been determined to publish a quarterly weather report which shall contain the continuous plates, with a current chronicle of the weather explanatory of them. The facts on which this chronicle is compiled are obtained partly from Branch III. and partly from Branch II. Any information derivable from ships' registers is also utilized.

In order to increase the amount of information received at the office, anemometers have been erected at various points on our coasts, and invitations have been issued to independent observers of known accuracy to assist the office in its work. These proposals were only sent out at the close of the year, but the Committee have already received great encouragement to hope for good results from the plan.

The cost of the department of land meteorology has been 3,174*l.* 5*s.* 2*d.*

Office.—The expenses of management, in salaries and wages, have been 1,562*l.* 1*s.* 3*d.* This sum will be reduced during the ensuing year, owing to Dr. Stewart's resignation of the secretaryship. The other charges incident on the office for rent, furniture, &c. &c., have amounted to 1,404*l.* 3*s.* 7*d.*

Arrangements have been made with the Kew Committee of the British Association for the examination of the curves and tabulations at that observatory.

The general supervision of the observatories has been transferred to Mr. Scott.

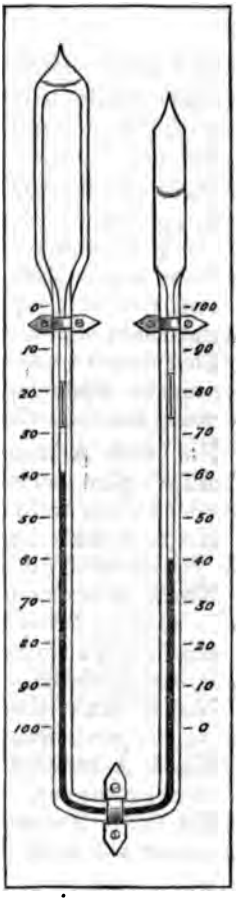
PART II.

DESCRIPTION of NEW INSTRUMENTS, &c., adopted by the METEOROLOGICAL COMMITTEE.

No. 1.—NOTE upon a SELF-REGISTERING THERMOMETER adapted to DEEP-SEA SOUNDINGS, by W. A. MILLER, M.D., Treasurer and V.P.R.S, extracted from Proceedings of Royal Society vol. xvii., p. 482.

It is well known that self-registering thermometers of the ordinary construction are liable to error when sunk to considerable depths in water, in consequence of the diminution produced for the time in the capacity of the bulb under the increased pressure to which it is subjected. The index, from this cause, is carried forward beyond the point due to the effect of mere temperature, and the records furnished by the instrument rise too high.*

A simple expedient occurred to me as being likely to remove the difficulty; and as upon trial it was found to be perfectly successful, I have thought that a notice of the plan pursued might not be unacceptable to future observers.



The form of self-registering thermometer which it was decided to employ is one constructed upon Six's plan. Much care is requisite in adjusting the strength of index-spring, and the size of the pin, so as to allow it to move with sufficient freedom when pressed by the mercury, without running any risk of displacement in the ordinary use of the instrument while raising or lowering it into the water. Several of these thermometers have been prepared for the purpose with unusual care by Mr. Casella, who has determined the conditions of strength in the spring and diameter of tube most favourable to accuracy. He has also himself had an hydraulic press constructed expressly with the view of testing these instruments. By means of this press the experiments hereafter to be described were made.

The expedient adopted for protecting the thermometers from the effects of pressure consisted simply in enclosing the bulb of such a Six's thermometer in a second or outer glass tube, which was fused upon the

* In sea water of sp. gr. 1·027, the pressure in descending increases at the rate of 280 lbs. upon the square inch for every 100 fathoms, or exactly one ton for every 800 fathoms.

stem of the instrument in the manner shown in the accompanying figure. This outer tube was nearly filled with alcohol, leaving a little space to allow of variation in bulk due to expansion. The spirit was heated to displace part of the air by means of its vapour, and the outer tube and its contents were sealed hermetically.*

In this way variations in external pressure are prevented from affecting the bulb of the thermometer within, whilst changes of temperature in the surrounding medium are speedily transmitted through the thin stratum of interposed alcohol. The thermometer is protected from external injury by enclosing it in a suitably constructed copper case, open at top and bottom, for the free passage of the water.

In order to test the efficacy of this plan, the instruments to be tried were enclosed in a strong wrought-iron cylinder filled with water, and submitted to hydraulic pressure, which could be raised gradually till it reached three tons upon the square inch, and the amount of pressure could be read as the experiment proceeded upon a gauge attached to the apparatus.

Some preliminary trials made upon the 5th of May showed that the press would work satisfactorily, and that the form of thermometer proposed would answer the purpose.

These preliminary trials showed that, even in the thermometers with protected bulbs, a forward movement of the index of from 0·5 to 1° F. occurred during each experiment. This, however, I believed was caused, not by any compression of the bulb, but by a real rise of temperature, due to the heat developed by the compression of the water in the cavity of the press.

This surmise was shown to be correct by some additional experiments made last week to determine the point. On this occasion the following thermometers were employed:—

No. 9645. A mercurial maximum thermometer, on Professor Phillips's plan, enclosed in a strong outer tube containing a little spirit of wine, and hermetically sealed.

No. 2. A Six's thermometer, with the bulb *protected*, as proposed by myself, with an outer tube.

No. 5. A Six's thermometer, with a long recurved cylindrical bulb, also *protected* in a similar manner.

No. 1. Six's thermometer, with cylindrical bulb of extra thickness, *not protected*.

No. 3. Six's thermometer, with spherical bulb, extra thick glass, *not protected*.

No. 6. Admiralty instrument, Six's thermometer, ebonite scale, bulb *not protected*.

No. 9651. An ordinary Phillips's maximum mercurial thermometer, spherical bulb, *not protected*.

The hydraulic press was exposed in an open yard, and had been filled with water several hours before. A maximum thermometer,

* See also p. 10.

introduced into a wrought-iron tube filled with water, open at one end to the outer air, closed at the other, where it passed into the water contained in the press, registered 46°·7 at the commencement, and 47° at the end of the experiment. Temperature of the external air 49° F.

In commencing the experiment, the seven thermometers under trial were introduced into the water in the cavity of the press, and after a lapse of 10 minutes the indices of each were set, carefully read, and each instrument was immediately replaced in the press, which was then closed, and by working the pump the pressure was gradually raised to 2½ tons upon the inch. It was maintained at this point for 40 minutes, in order to allow time for the slight elevation of temperature caused by the compression of the water to equalize itself with that of the body of the apparatus. At the end of the 40 minutes the pressure was rapidly relaxed. A corresponding depression of temperature was thus occasioned, the press was opened immediately, and the position of the indices of each thermometer was again read carefully; and the water was found to be at a temperature sensibly lower than before the experiment began, by about 0°·6 F. By this means it was proved that the forward movement of the index in the protected thermometers, amounting to 0°·9, was really due to temperature, and not to any temporary change in the capacity of the bulb produced by pressure.

This will be rendered evident by an examination of the subjoined table of observed temperatures :—

First Series : Pressure 2½ tons per square inch.

Number of Thermometer.	Minimum Index.		Maximum Index.		Maximum Mercury. After.
	Before.	After.	Before.	After.	
Protected - 9645	—	—	47·0	47·7	
„ - 2	47·0	46·5	46·7	47·6	46·5
„ - 5	47·0	46·3	46·5	47·6	46·0
Mean - -	—	—	—	47·6	
Unprotected - 1	46·7	46·4	46·5	54·0	46
„ - 3	47·0	46·5	46·5	56·5	46
„ - 56	47·0	46·0	47·0	55·5	46
„ - 9651	—	—	46·7	118·5	
Mean - -	46·9	46·3	46·7	—	46·1

Temperature of external air - -	49	49
Temperature of thermometer in press -	46·7	47

In the Phillips's maximum thermometer, with unprotected spherical bulb, No. 9651, the bulb had experienced so great a degree of compression as to drive the index almost to the top of the tube. In all the other unprotected instruments, which had been made with bulbs of unusual thickness, the index had been driven beyond its proper position from 6°·4 to 8°·9 F.; and it is obvious that the amount of this error must vary in each instrument with the varying thickness of the bulb and its power of resisting compression.

Notwithstanding the great pressure to which these instruments had been subjected, all of them, without exception, recovered their original scale-readings as soon as the pressure was removed.

It will be seen that the mean rise of temperature indicated by the three protected instruments was 0°·9 F., whilst the mean depression registered on removing the pressure amounted upon all the instruments which admitted of its measurement to 0°·6, an agreement as close as was to be expected from the conditions of the experiment.

A second set of experiments was made upon the same set of instruments, with the exception of 9651; but the pressure was now raised to 3 tons upon the inch; this was maintained for 10 minutes. When it had risen to $2\frac{3}{4}$ tons a slight report was heard in the press, indicating the fracture of one of the thermometers. On examining the contents of the press afterwards it was found that No. 2 was broken, the others were uninjured. The broken thermometer was the earliest constructed upon the plan now proposed, and it was consequently not quite so well finished as subsequent practice has secured for those of later construction. The results of the trial under the higher pressures showed an increase in the amount of compression experienced by the unprotected instruments, rising in one instance to as much as 11°·5 F. With the protected instruments the rise did not exceed 1°·5, due, as before, to the heat evolved from the water by its compression.

A pressure of 3 tons, it may be observed, would be equal to that of 448 atmospheres of 15 lb. upon the square inch; and if it be assumed that the diminution in bulk of water under compression continues uniformly at the rate of 47 millionths of its bulk for each additional atmosphere, the reduction in bulk of water under a pressure of 3 tons upon the square inch will amount to about $\frac{1}{47}$ of its original volume. This probably is too high an estimate, as the rate of diminution would most likely decrease as the pressure increases.

APPENDIX.

Since the date of the foregoing paper some additional trials of deep-sea thermometers have been made, the results of which may be of interest.

The first set of experiments were made in Capt. Toynbee's presence,

and the instruments tested were 12 of Dr. Miller's thermometers. One unprotected deep-sea thermometer (Pastorelli, 73), and one protected with a jacket of mercury (see p. 10) on the plan approved of by Admiral FitzRoy (Negretti, 19); both the latter instruments belong to the office.

The instrument used as "standard" throughout the experiments was the same thermometer as that described in Dr. Miller's paper.

First trial; pressure 2½ tons per square inch.

28th September 1869.

Number of Thermometer.		Minimum Index.		Maximum Index.		Mercury.
		Before.	After.	Before.	After.	After.
Standard - - -		- -	- -	60·5	61·1	
Protected by Spirit jacket.	1 -	60·5	60·5	60·5	62·0	Not recorded.
	2 -	60·3	60·1	60·4	61·8	
	3 -	60·3	60·2	60·3	62·0	
	4 -	60·2	60·1	60·3	61·4	
	5 -	60·2	60·2	60·5	61·8	
	6 -	60·2	60·1	60·3	61·5	

Result:—The minimum indices in no case affected by pressure; the standard rose 0°·6, and the maximum indices rose on an average 1°·37.

Second trial; pressure 2½ tons.

Standard - - -	- -	- -	61·0	61·3	61·0
Protected by spirit jacket. 7 -	60·8	60·5	60·8	62·0	60·9
8 -	60·7	60·5	60·8	62·0	60·8
9 -	60·5	60·3	60·5	61·5	60·5
10 -	60·4	60·5	60·8	62·0	60·6
11 -	60·8	60·8	61·0	61·8	60·8
12 -	60·7	60·5	60·8	62·0	60·6

Result:—Little or no effect upon minimum indices, standard rose 0°·3, maximum indices rose 1°·10.

Third trial; pressure 2½ tons.

Number of Thermometer.	Minimum Index.		Maximum Index.		Mercury.
	Before.	After.	Before.	After.	After.
Standard - - -	- -	- -	61·2	61·4	—
Pastorelli 73 - -	61·0	61·0	60·8	71·5	61·0

Result:—This thermometer was an ordinary Six's, without protection; the minimum was not moved; the maximum rose 10°·7; the standard rose 0°·2.

Fourth trial; pressure 1 ton.

Standard - - -	- -	- -	61·2	61·5	—
Negretti, 19 - -	61·0	61·0	61·0	61·5	61·3

Fifth trial; pressure 2 tons.

Standard - - -	- -	- -	61·2	61·6	61·3
Negretti, 19 - -	61·0	61·3	61·0	62·6	61·3

Sixth trial; pressure 2½ tons.

Standard - - -	- -	- -	61·5	61·8	61·5
Negretti, 19 - -	61·2	61·0	61·2	63·0	9·19

One ton had no sensible effect on this instrument; two tons raised the maximum index 1°·6; and 2½ tons raised it 1°·8. The result of the experiments with this thermometer shows that as regards power of resisting compression it is fully comparable with the new instruments.

It is noticeable that the standard rose the same amount 0·3 under all pressures. This may be due to heat developed by friction or compression. Regarding it as such, the following resumé shows the effect of compression or pressure *per se*.

	Thermometer Rise due to			Tons per Inch.
	Heat and Pressure.	Heat.	Pressure.	
Standard - - -	0·6	0·6	0·0	2½
1 - - -	1·5	„	0·9	„
2 - - -	1·4	„	0·8	„
3 - - -	1·7	„	1·1	„
4 - - -	1·1	„	0·5	„
5 - - -	1·3	„	0·7	„
6 - - -	1·2	„	0·6	„
Standard - - -	0·3	0·3	0·0	„
7 - - -	1·2	„	0·9	„
8 - - -	1·2	„	0·9	„
9 - - -	1·0	„	0·7	„
10 - - -	1·2	„	0·9	„
11 - - -	0·8	„	0·5	„
12 - - -	1·2	„	0·9	„
Standard - - -	0·2	0·2	0·0	„
73 - - -	10·7	„	10·5	„
Standard - - -	0·3	0·3	0·0	1
19 - - -	0·5	„	0·2	„
Standard - - -	0·3	0·3	0·0	2
19 - - -	1·6	„	1·3	„
Standard - - -	0·3	0·3	0·0	2½
19 - - -	1·8	„	1·5	„

Two other thermometers were tested on the 8th of December, and the results present some features of interest.

Thermometers by Casella, Nos.	Minimum Index.		Maximum Index.		Mercury. After.	Pressure on the Square Inch.
	Before.	After.	Before.	After.		
	°	°	°	°	°	Tons.
1st Trial { Stand. 9,645	—	—	48·9	49·0	49·0	1½
1st Trial { 11,678	48·5	48·5	48·7	49·3	48·6	1½
1st Trial { 11,679	48·5	48·5	48·8	49·1	48·6	1½
2nd Trial { Stand. 9,645	—	—	48·4	48·5	47·6	2½
2nd Trial { 11,679	48·3	47·6	48·3	49·0	47·6	2½
3rd Trial { Stand. 9,645	—	—	47·9	47·9	47·2	2½
3rd Trial { 11,678	47·5	47·2	47·5	48·4	47·2	2½

—	Rise of Thermometer due to			Tons per Inch.
	Heat and Pressure.	Heat.	Pressure.	
9645	0·1	0·1	—	1¾
11678	0·6	0·1	0·5	1¾
11679	0·3	0·1	0·2	1¾
9645	0·1	0·1	—	2½
11679	0·7	—	0·6	2½
9645	− 0·7	− 0·7	—	2½
11678	0·9	„	1·6	2½

It will be noticed that the change of reading of the standard thermometer was not constant, as in some of the experiments a rise of 0°·1 was observed, while in one a fall of 0°·7 was recorded. This latter result is probably due to the fact that the hydraulic press was not in very good order, so that a large quantity of water at a lower temperature than the surrounding air had to be drawn through the apparatus before the pressure began to act on the gauge.

The foregoing experiments are sufficient to show that the new instruments perform satisfactorily, and also that the original thermometers described by Admiral FitzRoy were good and trustworthy instruments in so far as regards their capability of resisting pressure.

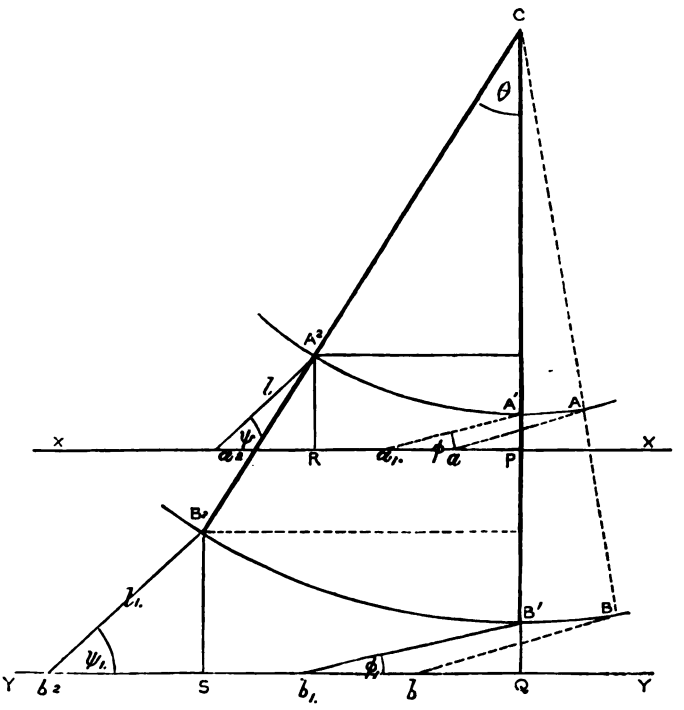
No. II.

On the PRINCIPLE of the PANTAGRAPH designed by F. GALTON.

In the pantagraph I have designed to reduce the tracings of the various self-recording meteorological instruments, the reduction is effected by two separate but similar actions, in length and in breadth. One hand of the operator controls the movements from side to side of the original tracing and of the plate that receives the reduced figure; the other hand controls the movements up and down of the style that passes over the original figure, and of the point that scratches the reduced copy. In both cases the reduction is effected by means of an arm connected through links with carriages compelled to run along parallel lines.

The following analysis shows the conditions of length and position that have to be observed in making and adjusting the instrument, and I shall now restrict my explanation to this, because although the existing instrument works very satisfactorily, yet the new one (which is not yet sufficiently finished to

make a drawing from) will be its superior in range of adjustment and in many other points of detail. It is therefore advisable to delay the description until the new instrument shall have been some time at work, and its appurtenances brought into perfect order.



C A B is an arm which can be moved round C to any desired position as C A_1 B_1 or C A_2 B_2.

a is a point on a carriage that moves along a tramway, or is otherwise guided, so that it may be pushed to any desired position in the line X X, but nowhere else. It is connected with C A B by a link A*a*, and therefore assumes the positions a_1 a_2, corresponding to the positions of the arm C A_1 B_1, C A_2 B_2.

Similar arrangements are made in respect to B, and the two tramways are made parallel to one another.

Required to find the conditions, if any, that will cause the movements of *a* and *b* to bear a uniform proportion to one another.

Take C A_1 B_1 perpendicular to the tramways, and let C A_2 B_2 be any other position of the arm. Let fall the perpendiculars A_2 R and B_2 S.

Call the vertical angle θ; call the angle $A_2 a_2 P$, ψ; the angle $A_1 a_1 P$, φ; and the link A*a*, l.

Let the corresponding values in the arrangement connected with B, be ψ_1, φ_1, and l_1.

Now ψ is known in terms of the rest, because

(1) $l \sin \psi = C A \operatorname{versin} \theta + l \sin \varphi$, and so for ψ_1,

therefore our problem is to find the relations (if they exist) between φ and φ_1; l and l_1; C A and C B; that shall ensure the space of $a_1 a_2$ to bear a constant relation to $b_1 b_2$, = say $\frac{1}{c}$, for all values of θ.

$$a_1 a_2 = \mathrm{P}a_2 - \mathrm{P}a_1 = \mathrm{R}a_2 + \mathrm{R\,P} - \mathrm{P}a_1$$
$$b_1 b_2 = \mathrm{Q}b_2 - \mathrm{Q}b_1 = \mathrm{S}b_2 + \mathrm{S\,Q} - \mathrm{Q}b_1$$

$$\frac{a_1 a_2}{b_1 b_2} = \frac{l\cos\psi + \mathrm{C\,A}\sin\theta - l\cos\varphi}{l_1\cos\psi_1 + \mathrm{C\,B}\sin\theta - l_1\cos\varphi_1} = \frac{1}{c}$$

but from (1) $l\cos\psi = l\sqrt{1-\sin^2\psi} = \sqrt{l^2 - (l\sin\varphi + \mathrm{C\,A\,vers.}\,\theta)^2}$

and similarly for $l_1\cos\psi_1$

$$\text{therefore } \frac{\sqrt{l^2 - (l\sin\varphi + \mathrm{C\,A\,versin}\,\theta)^2} + \mathrm{C\,A}\sin\theta - l\cos\varphi}{\sqrt{l_1^2 - (l_1\sin\varphi_1 + \mathrm{C\,B\,versin}\,\theta)^2} + \mathrm{C\,B}\sin\theta - l_1\cos\varphi_1} = \frac{1}{c}.$$

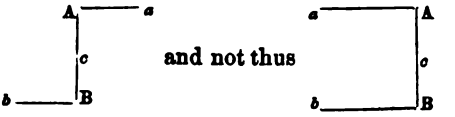
First, we see that these values can be real only so long as $l\sin\varphi + \mathrm{C\,A\,versin}\,\theta$ (or $\mathrm{A_2\,R}$) is less than l; or the distance between A and the tramway is less than the length of the link, a fact which is evident enough on inspection of the figure.

Secondly, the equation holds for the combined values

$$\varphi = \varphi_1, \frac{l}{l_1} = \frac{1}{c}, \frac{\mathrm{C\,A}}{\mathrm{C\,B}} = \frac{1}{c}, \text{ and for no other ones.}$$

We may simplify the conditions yet further, by making $\varphi = \varphi_1 = o$; that is to say, by so arranging the instrument that the link shall be parallel to the tramway when C A B is perpendicular to it; in this case the adjustment of $\frac{\mathrm{C\,A}}{\mathrm{C\,B}} = \frac{1}{}$ must be made by varying the position of C, while those of A and of B remain intact. This is the arrangement adopted in the pantagraphs already made.

If it be desired that $\frac{1}{c}$ should be negative, or $\frac{l}{l_1} = -\frac{1}{c}$, and $\frac{\mathrm{C\,A}}{\mathrm{C\,B}} = -\frac{1}{c}$, *i.e.*, that the movements of the arms should be in contrary directions, or that the reduction should be reversed, then $l = \frac{-l_1}{c}$ and $\mathrm{C\,A} = \frac{-\mathrm{C\,B}}{c}$ consequently both l_1 and C B having opposite signs to l and C A, the arms will lie thus :—



First adjustment:—To find the position of C so that $\frac{\mathrm{C\,A}}{\mathrm{C\,B}}$ shall $= \frac{1}{c}$.

(1) When A lies between C and B

$$\frac{\mathrm{C\,A}}{\mathrm{C\,B}} = \frac{\mathrm{C\,A}}{\mathrm{C\,A} + \mathrm{A\,B}} = \frac{1}{c}, \text{ or } \mathrm{C\,A}\,(c-1) = \mathrm{A\,B},\ \mathrm{C\,A} = \frac{\mathrm{A\,B}}{c-1}$$

(2) When C lies between A and B (reverse action)

$$\frac{\mathrm{C\,A}}{\mathrm{C\,B}} = \frac{\mathrm{C\,A}}{\mathrm{A\,B} - \mathrm{A\,C}} = \frac{1}{c}, \text{ or } \mathrm{C\,A} = \frac{\mathrm{A\,B}}{c+1}.$$

Hence A B ought to be divided into some convenient number of graduations, and one that is divisible in many ways, such as 60; and

the graduations should be numbered from A towards B. The same scale of divisions should be continued on the other side of A, and those graduations should be separately numbered, beginning also from A. It is then easy to find the position of c. For example, if it be required to reduce to $\frac{1}{4}$, $c = \frac{1}{4}$.

(1) Direct reduction : Set C among the upper graduations at $\frac{60}{4-1}$ or at 20; then $CA = 20$, $CB = CA + AB = 80$, and $\frac{CA}{CB} = \frac{20}{4 \times 20}$

(2) Reverse reduction : Set C among the lower graduations at $\frac{60}{4+1}$ or at 15; then $CA = 15$, $CB = 60$, and $\frac{CA}{CB} = \frac{15}{4 \times 15}$.

Second adjustment:—To find the position of a so that $\frac{Aa}{Bb}$ shall $= \frac{1}{c}$, it being, at the same time, required that CB and Bb shall remain intact.

Since, in the two triangles C A a, C B b, the sides C A, A a are proportional to C B, B b, and since C A a, C B b are right angles, as also the vertical angles at C are identical in case (1) and equal in case (2), it follows that the triangles are similar, and that C a b is a straight line. Consequently, after making the adjustment described in the last paragraph, of $\frac{CA}{CB} = \frac{1}{c}$, we have simply to shift a into the line C b, and the adjustment is complete.

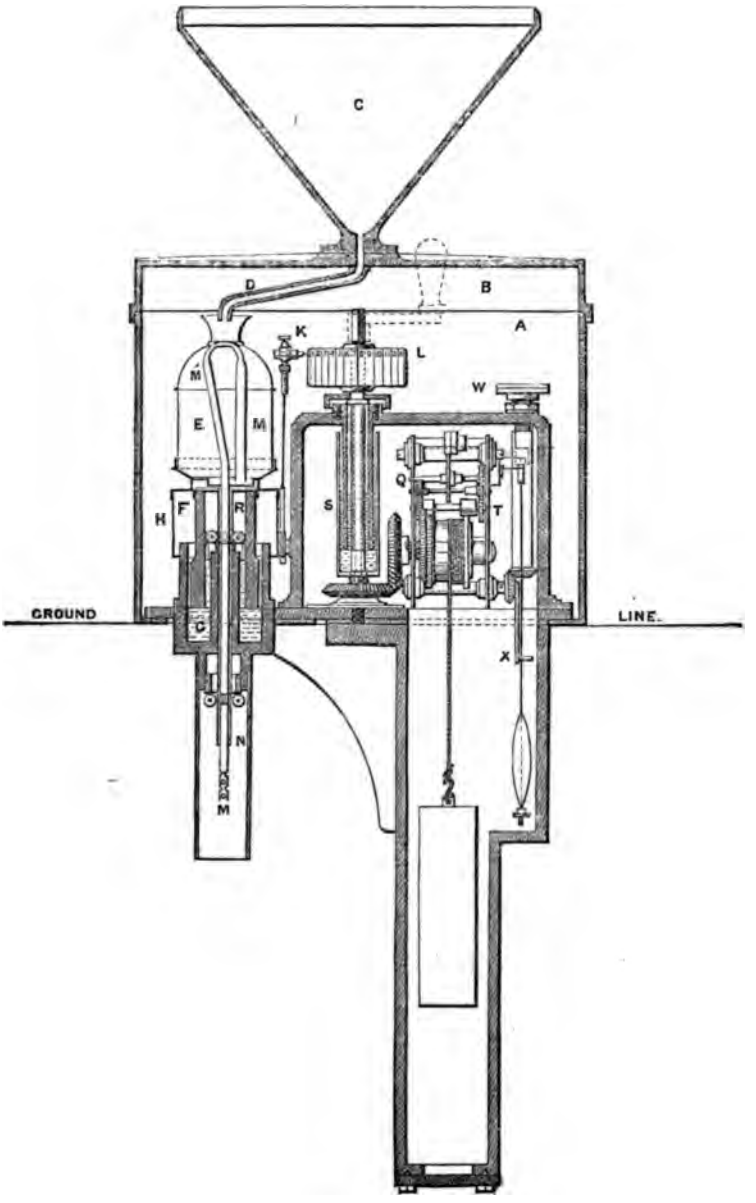
These adjustments of C and of a are mechanically effected on the same principle that is employed in shifting the centre of the well-known instrument, the proportional compasses.

FRANCIS GALTON.

No. III.

Description of a Self-Recording Rain-Gauge, invented by Robert Beckley, of the Kew Observatory; made by James Hicks, London.

The instrument is shown in the annexed plate, a section being given of the whole :—



(A) is a cubical box of thin cast iron, 13 inches square and 11 deep, furnished with a loosely-fitted hinged cover (B). The top of the cover is stiffened by four ribs which meet at a boss in the centre, into which the funnel (C) is screwed. The funnel is also of cast iron, but its interior surface after having been turned is enamelled, in order to prevent rusting. It is provided with a lip to retain the splashes, which is 1¼ inches deep, and is turned accurately to a circle of 11¼ inches diameter, giving an area of exposure of 100 square inches. A small aperture in the bottom of the funnel opens into a pipe (D), which conducts the water, as it is collected, into the copper bottle or receiver (E); this is supported by a hollow ebonite cylinder (F) floating in mercury contained in the annular vessel or cistern (G). As water enters the receiver the float descends in the cistern, displacing more mercury the further it goes; the relation between the area of the cistern and float being so proportioned that the entrance of equal quantities of water into the vessel (E) shall cause its descent to take place through equal spaces. A cover (H) fixed to the top of the float supports on one side a spring, the upper extremity of which is adapted to hold a pencil (K) which presses against a cylinder (L) covered with waterproof paper, marking on it vertical lines as the float with the receiver rises and falls. When the level of the water in the receiver reaches the neck of the vessel (E), which has then descended to its lowest point, the syphon (M) comes into play, and rapidly discharging the water, enables the receiver to rise and resume its original position, while at the same time the pencil (K) marks a line from the bottom to the top of the cylinder. As the receiver (E) has a capacity of 20 cubic inches this occurs whenever two-tenths of an inch of rain has fallen. The syphon (M) acts on the principle of the intermittent syphon, modified and adapted so as to enable it to act accurately and with certainty in the present case. As the water enters the vessel (E) it rises in the short leg (M) of the syphon, driving the air before it through the long leg (M′ M″). This continues until it reaches the bend at the top, when it flows down the long leg and brings the syphon into play, and then runs until the vessel (E) is quite emptied (a small depression in the bottom materially assisting it), and the air can enter at the lower extremity of the short leg. The flattened contracted bend of the syphon answers the double purpose of preventing the entrapment of an air-bubble in the bend, and also of ensuring that the vessel shall always be emptied immediately the water in it arrives at a constant fixed height, while at the same time sufficient area is left not to retard the flow of water through it. In order to prevent the retention of a few drops of water by capillary action in the lower extremity of the tube several small apertures are made at M″; these, by admitting air and also allowing the lateral escape of the fluid, effectually prevent all stoppage from this cause. The action of the syphon as thus constructed is so certain and constant that it is found on experiment that if the water running out of the

receiver, when it is discharging itself, be caught in some vessel and returned to the receiver, the syphon will not commence to act until the last drop is poured back. The long leg of the syphon, on issuing from the under side of the receiver (E), passes down a brass tube (N N), through the centre of the mercury cistern guided by rollers (R) fixed to the cistern, which serve to keep the float and receiver perfectly vertical and central. In the experimental forms of this instrument some difficulty was caused by the oxidation of the surface of the mercury in the cistern preventing the moving of the float with sufficient ease and freedom; but a suggestion of Mr. Hicks completely removed this source of annoyance. It consists in pouring a small quantity of glycerine over the surface of the mercury, which by acting in a measure as a lubricating fluid causes the movement of the float to be extremely delicate. The registering part of the apparatus consists of a clock (Q) turning a cylinder (L) at an uniform rate, the pencil (K) marking on the cylinder. The pencil is a piece of ordinary black-lead pencil fixed in a holder capable of being raised and lowered by an adjusting piece. This piece is fastened to the top of a flat metal spring which terminates below in a small brass bar screwed to the cistern cap, and running up and down between two friction rollers (R) to destroy any lateral movement. The cylinder (L) fits easily on the clock spindle, but is capable of being fixed in any position on it, and the paper with which it is surrounded is divided by engraved lines into 24 hour spaces. The clock (Q) is contained in a hermetically closed case, the two places where communication takes place between the interior and exterior being guarded by mercurial stuffing boxes (S and T). S is the vertical axis supporting and giving motion to the cylinder, being driven round by the clock once every day. By means of a peculiar adaptation of the wheel-work of the clock a reversal of this motion winds it up, a handle (shown by dotted lines in the figure) being temporarily fitted on to the end of it, which is made square for that purpose. The upper bearing of this axle is formed of a tube which surrounds it loosely for the greater part of its length. This tube is again contained in a larger tube closed at the lower extremity and fastened to the axis. Mercury is then poured into the tube, half filling it, and so preventing the passage of air either into or out of the clock case, but allowing it to expand under varying changes of temperature, whilst at the same time freedom from friction of the axle in its bearings is retained. A similar arrangement at T serves to put the pendulum in motion. On turning the milled head (W) on the exterior of the case, movement is imparted by bevilled wheels to a small arm (X), which pressing against the pendulum rod forces it out of its vertical position; immediately the pressure is removed from the head (W) the arm (X) falls back to its original place by its own weight, leaving the pendulum vibrating freely. The clock case is recessed at the bottom to a sufficient depth to allow the weight to fall for one day. The clock mechanism can readily be altered so as to go

any number of days, and the time scale can be made of any desired length; but in the present instrument the time scale adopted is that chosen by the Meteorological Committee for their other self-recording instruments.

The rain-gauges supplied by the office to the telegraphic reporting stations are on Glaisher's pattern, but have been improved in construction. They are of copper, and are neither painted nor japanned. Their aperture is circular, 8 inches in diameter. The measuring glasses are of uniform pattern, and are carefully tested before issue. The receiver of the gauge is made deep enough to collect at least 8 inches of snow. It has a straight sharp edge without any flange or shoulder, so that there can be no possibility of the rain splashing in or out. The receiver fits *on* not *into* the vessel containing the collecting can, so that no water can be blown into this can at the joint.

APPENDIX.

APPENDIX I.

METEOROLOGICAL OFFICE REVENUE and EXPENDITURE ACCOUNT for the year ending 31st March 1870.

Dr. REVENUE.				CR. EXPENDITURE.					
To Parliamentary Vote	£10,000	0	0	OFFICE:					
„ Balance from year 1868–9	1,743	11	3	By Salary of Director	£800	0	0		
„ Earl of Stair	4	5	0	„ Secretary to Committee	400	0	0		
„ Proprietors and Fishermen of Downies	4	5	0	„ Two Clerks	209	7	6		
„ H. Lee & Sons	2	10	0	„ Office-keeper and Messenger	152	13	9		
„ W. W. Rundell	12	12	6					£1,562	1 3
„ G. Dornbusch	10	0	0	„ Rent of Office	376	17	0		
„ J. Balbirnie	4	5	0	„ Furniture and Fittings	751	15	9		
„ Hill & Price	5	10	0	„ Postage	90	19	7		
Rev. C. H. Griffith	2	10	0	„ Printing, &c.	44	17	3		
Telegraph Maintenance, &c. Company	3	0	4	„ Travelling Expenses	9	11	11		
„ Rev. J. T. Waller	0	10	8	„ Fuel and Gas	19	19	11		
„ Cork Harbour Commissioners	4	11	0	„ Attendance, Cleaning, and other Contingencies	110	2	2		
„ Capt. J. Wessendorff	4	5	0					1,404	3 7
„ J. G. Gamble	2	10	0	LAND METEOROLOGY:					
„ Sale of old instruments	29	6	9	By Expenses at Observatories	2,277	3	9		
„ Sale of Signal Staff	1	9	9	„ New Instruments for do.	519	15	2		
„ Interest on deposit account	70	3	5	„ Computations	377	6	3		
								3,174	5 2
				„ Telegrams	2,193	16	7		
				„ Inspections and other Expenses	87	9	11		
				„ Computations	357	13	7		
								2,639	0 1
				OCEAN METEOROLOGY:					
				By Marine Superintendent	400	0	0		
				„ Supply and Return of Instruments:					
				Admiralty	111	13	6		
				Mercantile Marine	262	8	5		
				„ Computations and Care of Instruments	864	19	7		
								1,639	1 6
								10,418	11 7
				„ Cash in hand	35	12	7		
				„ Advance to Valencia Observatory	50	0	0		
				„ Bank of England account	285	5	1		
				„ London and Westminster Bank	1,115	16	5		
								1,486	14 1
	£11,905	5	8					£11,905	5 8

Examined and compared with the vouchers and found correct.

(Signed) J. P. GASSIOT, W. SPOTTISWOODE, } Auditors.

4 May 1870.

APPENDIX II.

The number of ships supplied during the year 1869 was 54, of which number 13 belonged to the various steam-ship companies now collecting observations for this office.

The above statement does not refer to ships in the Royal Navy, all of which are supplied with meteorological instruments from the office.

In addition to the registers returned from the ships referred to, documents amounting altogether to 36 in number have been registered during the year 1869, containing observations made at the following places:—

Place.	Observer.	Nature of Observations.
Australia (west coast)	Lightkeeper	Lighthouse Registers (2 stations).
Bermuda	Dockyard Authorities	Anemometrical Records.
Brazil	Rev. C. J. Nicolay	Daily observations of barometer and thermometer, and remarks on winds and weather; years 1858–9 and 1861–2.
Ceylon (Point de Galle)	D. Blyth (Master Attendant)	Daily observations and monthly means.
Falkland Islands (Cape Pembroke)	Lightkeeper	Lighthouse register.
London (Charing Cross)	W. Bone	Daily observations (corrected and reduced) and diagrams; year 1844.

APPENDIX II.—A List of Documents received from Ships during the year 1869.

Captain's Name.	Ship.	Tons.	Owners.	Voyage.	Months of Register.
Aird, A. D.*	S.S. Nestorian	1,528	Allan Brothers, Glasgow	Five voyages to and from Quebec	3
Angel, John	Twilight	630	E. Bates, Liverpool	To and from Bombay	8
Balderston, R. I.	Bowfell	1,001	T. & R. Brocklebank, Liverpool	To and from Calcutta	6
Ballintine, W.	S.S. Peruvian	1,432	Allan Brothers, Glasgow	Seven voyages to and from Montreal	7
Beal, T. S.†	S.S. Ruahine	1,018	P. N.Z. & A. R.M. Co.	Four voyages from Sydney to Wellington and Panama, and three returns.	8

* Meteorological Register was kept chiefly by G. Scott, 1st Officer.
† " " by J. L. Stalker, 2nd Officer.

LIST of DOCUMENTS, &c.—*continued.*

Captain's Name.	Ship.	Tons.	Owners.	Voyage.	Months of Register.
Bedford, G. A.	Admiralty Survey	—	- - - - -	West Coast of Ireland - - -	98
Bird, Edward	S.S. Mataura	1,114	P. N.Z. & A. R.M. Co.	Two voyages to from Panama to Wellington, then to Rio Janeiro and Southampton.	6
Blake, E. J.	Panic	449	E. Bates, Liverpool	To and from Cocoanada - - -	8
Brooker, E. W.	Sylvia	695	H.M.S. - - -	Surveying in Chinese Seas - -	7
Brooks, Samuel	S.S. City of London	1,880	W. Inman, Liverpool	Six voyages to and five from New York -	4
" "	S.S. City of Brooklyn.	—	W. Inman, Liverpool	Six voyages to and from New York -	4
Brown, Robert*	S.S. Moravian	1,527	Allan Brothers, Glasgow	Five voyages to and from Quebec -	4
Bythesea, John†	Phœbe	2,896	H.M.S. - - -	To Halifax, Bermuda, and West Indies -	5
Campbell, C. A.; and Wilson, J. C.‡	Narcissus	2,665	H.M S. - - -	To, at, and from East Coast, South America.	54
Carruthers, F. P.	Minero	478	C. L. Claude, California	To Valparaiso and from Coquimbo -	7
Cochrane, the Hon. A. A.	Niger	—	H.M.S. - - -	Temperature of the sea, from England to China.	—
Cook, T.§	S.S. Russia	1,710	J. F. J. Burns, Glasgow	Two voyages to and from New York -	2
Darke, J. W. B.	S.S. Kaikoura	1,068	P. N.Z. & A. R.M. Co.	Three voyages, Sydney to Wellington, Panama, and back.	7
" "	S.S. Ruahine	1,018	P. N.Z. & A. R.M. Co.	Sydney to Wellington, Rio Janeiro, and Southampton.	2
Fairlem, Henry	Ganges	1,185	Clint & Co., Liverpool	To and from Calcutta - - -	6
Finlay, James	Duncairn	1,303	W. P. Sinclair, Liverpool	To Bombay, Akyab, and home - -	8
Fletcher, A. W. D.	Spiteful	1,054	H.M.S. - - -	At Monte Video - - - -	1
Fry, Alfred	Foam	311	R. & W. King, Bristol	To, at, and from West Coast of Africa -	17
Gamble, H. C.	Forfarshire	1,238	J. Morison, London	To and from Calcutta - - -	6
Harrison, J.	S.S. Aleppo	1,399	Burns & MacIver, Liverpool	Four voyages to and from New York, via Boston.	4
Hassell, T. E.	Mervyn	306	R. & W. King, Bristol	To and from Cape Palmas - -	5

* Meteorological Register was kept chiefly by John G. Stephen, 1st Officer.
† " " " by John A. B. Petch, Navigating Lieutenant.
‡ " " " by James S. Watts, Navigating Lieutenant.
§ " " " by W. Greenwood.

List of Documents, &c.—*continued.*

Captain's Name.	Ship.	Tons.	Owners.	Voyage.	Months of Register.
Hayes, James	S.S. Cassini	687	Brazil and River Plate S.N. Co.	Two voyages to and from Monte Video, &c.	6
" "	S.S. Ptolemy	758	Brazil and River Plate S.N. Co.	Two voyages to and from Rio Janeiro, &c.	4
" "	" "	758	Brazil and River Plate S.N. Co.	To and from Buenos Ayres, &c.	3
Henderson, Henry	Hope	454	J. Robinson	Shanghai to Newchwang, Swatow, Hong Kong, London.	8
Hicks, G. W.*	Indus	1,319	R. M. S. P. Co., London	To and from Bombay	7
Hillyar, F.†	Octavia	3,161	H.M.S.	Madeira to Sierra Leone, Cape of Good Hope, and Bombay.	4
Hunter, David	S.S. Alpha	514	W. Cunard, Halifax	Six voyages from Halifax to Bermuda, St. Thomas, and back.	4
" "	S.S. Alpha	514	W. Cunard, Halifax	Eleven voyages, Halifax to Bermuda, St. Thomas, and back.	7
Irminger (Admiral)	Danish ships	—	—	Sea temperature between Greenland and Shetland.	—
Jones, A. A.	Victoria Nyanza	1,022	J. Prowse, Liverpool	To and from San Francisco	8
Judkins, C. H. E.‡	S.S. Scotia	2,125	Burns & MacIver, Liverpool	To and from New York	1
" "	" "	2,125	Burns & MacIver, Liverpool	Four voyages to and from New York	3
Le Messurier, F.	S.S. Tripoli	1,401	Burns & MacIver, Liverpool	Eight voyages to, and nine from New York	6
Lott, E. G.§	S.S. Samaria	1,695	J. Burns, Glasgow	To and from New York	1
Martyn, J. A.	S.S. Siberia	1,698	J. Burns, Glasgow	Four voyages to and from New York	4
Mayne, R. C.; C.B.‖	Nassau	695	H.M.S.	On coast of South America, thence to England.	16
Moodie, E. R.	S.S. Cuba	1,534	Burns & MacIver, Liverpool	Eight voyages to, and nine from New York	8
Moore, J. S. L.	Prince Albert	—	Hudson Bay Co.	To and from Hudson Bay	4
Morton, J. D'Arcy	Henry Bath	490	H. Bath & Son, Swansea	To and from Coquimbo	8
Mossop, Clement	Candahar	1,418	T. & R. Brocklebank, Liverpool	To and from Calcutta	7
Murphy, Michael	S.S. Siberia & Tarifa	—	Burns & MacIver	Nine voyages to and from New York, via Boston.	8
Nelson, J. E.	Philip Nelson	547	P. Nelson, Liverpool	To Bombay, and from Cochin	8

* Meteorological Register was kept chiefly by S. W. Hodding, 2nd Officer.
† " " " by Thomas Pounds, Staff Commander.
‡ " " " by W. Greenwood.
‖ " " " by D. G. Tandy, Lieutenant.

LIST of DOCUMENTS, &c.—*continued.*

Captain's Name.	Ship.	Tons.	Owners.	Voyage.	Months of Register.
Pearce, Robert*	Malabar	1,219	H. Green, London	London to Madras, Calcutta, to and at Annesley Bay.	9
Rawle, Charles	Star of the North	662	A. Pardew, Plymouth	To Bombay, Aden, Tuticorin, and home	10
Raymond, C. T.	British India	1,199	British Shipowners' Co.	To and from Bombay	7
Revett, Richard	S.S. Atrato	1,970	R. M. S. P. Co., London	Four voyages to and from Colon, &c.	8
Shaw, G.	S.S. Alpha	514	W. Cunard, Halifax	Two voyages, Halifax to Bermuda, St. Thomas, and back.	1
Smith, W. H.	S.S. Hibernian	1,392	Allan, Bros., Glasgow	Five voyages to and from Quebec	4
Spragge, Robert	Mary Hardy	495	Hardy & Sons, London	To and from Barbadoes	2
Studdert, Robert	Hotspur	1,142	T. E. Smith, Gosforth	To Calcutta, Madras, and home	9
Thompson, J. M.	British American	1,207	C. Hill, Bristol	To Monte Video, Callao, and home	7
Tucker, J. W.	John Temperley	976	J. C. Hall, Durham	London to Melbourne, Calcutta, Melbourne, Calcutta, Cochin, and back to London.	13
Tully, Thomas	Baroda	1,364	T. Brocklebank, Liverpool	To and from Calcutta	7
Vinnis, Francis	Robinson Crusoe	1,165	J. Beazley, Liverpool	To and from Bombay	7
(Unknown)	S.S. Oriental	—	P. & O. S. N. Co.	Abstract of two voyages from Bombay to Suez and back.	—
(Unknown)	S.S. Nemesis	—	P. & O. S. N. Co.	Abstract of 13 voyages from Calcutta to Suez and back.	—
(Unknown)	S.S. Nemesis	—	P. & O. S. N. Co.	Abstract of voyage from Calcutta to Bombay and back.	—
Warren, W. H. C.	Brilliant	303	C. Saunders, Liverpool	To Yokohama	4
Watson, T. O.	Peter Joynson	956	P. Joynson, Liverpool	From Calcutta	4
Watson, William	S.S. Palmyra	1,390	J. Burns, Glasgow	Eight voyages to and from New York	8
Watt, H. F.	Christabel	171	H. F. Watt, Liverpool	To St. Thomas, St. Domingo, and home	3
Wherland, F.	Galatea	1,477	S. R. Graves, Liverpool	To and from Calcutta	8
Whiteway, Lewis	Dennis Brundrit	462	P. Whiteway, Runcorn	To and from Valparaiso	7
Wight, H. P.	Gosforth	810	T. E. Smith, Gosforth	To and from Madras	7
Wood, Henry	Excelsior	494	J. Flamank, Teignmouth	To and from New Zealand	8
Woolward, Robert	S.S. Douro	1,785	R. M. S. P. Co., London	Three voyages to and from Colon, one to and from Rio Janeiro.	7
Wright, S. H.†	S.S. Rakaia	938	P. N.Z. & A. R. M. Co.	Three voyages from Panama to Wellington, Sydney, and back.	7

* Meteorological Register was kept chiefly by Henry Colston, Surgeon.
† " " T. F. Orchard.

APPENDIX III.

INSTRUMENTS supplied, &c. to the Royal Navy.

	Barometers.	Aneroids.	Thermometers.			Hydrometers.
			Ordinary.	Max.	Min.	
January 1st, 1869, afloat	188	416	806	10	12	161
Issued in 1869	38	74	213	28	22	24
	226	490	1,019	38	34	185
Returned in 1869	56	111	213	31	20	42
January 1st, 1870, afloat	170	379	806	7	14	143

INSTRUMENTS supplied, &c. for use at Naval Stations, and by Admiralty Surveys by Shore Parties, &c.

January 1st, 1869, in use	63	81	133	32	30	39
Issued in 1869	4	11	19	2	3	—
	67	92	152	34	33	39
Returned in 1869	14	31	55	16	14	24
January 1st, 1870, in use	53	61	97	18	19	15

DISPOSITION of ADMIRALTY INSTRUMENTS on January 1st 1870.

	Barometers.	Aneroids.	Thermometers.			Hydrometers.
			Ordinary.	Max.	Min.	
Afloat in Royal Navy	170	379	725	7	14	143
At stations for use	53	61	97	18	19	15
In store, at M.O.	171	105	224	62	56	161
„ Chatham	2	5	18	2	2	17
„ Sheerness	14	14	33	14	13	9
„ Portsmouth	18	15	29	5	4	18
„ Devonport	7	11	23	3	4	42
„ Queenstown	1	4	6	2	2	8
„ Gibraltar	4	4	6	1	1	4
„ Malta	2	9	47	2	2	28
„ Halifax	5	5	20	—	—	4
„ Bermuda	6	7	9	1	1	16
„ Jamaica	6	4	7	2	1	8
„ Ascension*	2	4	7	—	—	—
„ Cape of Good Hope	3	9	—	—	—	16
„ Hong Kong†	10	24	45	—	—	24
„ Vaiparaiso‡	4	1	23	2	2	16
Total, per account	478	661	1,319	121	121	529
Lost, &c. during 1869	27	34	179	23	16	45

* No return has been made since 20th October 1868.
† No return has been made since 1st January 1868.
‡ No return has been made since 1st January 1869.

APPENDIX IV.

INSTRUMENTS supplied, &c. to the Mercantile Marine.

	Barometers.	Compasses.	Thermometers.			Hydrometers.
			Ordinary.	Max.	Min.	
January 1st, 1869, afloat -	62	12	393	—	—	254
Issued in 1869 - -	52	4	305	—	—	197
	114	16	698	—	—	451
Returned in 1869 -	45	8	268	—	—	168
January 1st, 1870, afloat -	69	8	430	—	—	283

INSTRUMENTS in use at Stations, viz., Telegraph Offices, Lighthouses, Observatories, Navigation Schools, &c.

January 1st, 1869, in use	101	7	254	40	39	55
Issued in 1869 - -	20	1	40	6	11	10
	121	8	294	46	50	65
Returned in 1869 -	27	3	70	11	14	7
January 1st, 1870, in use	94	5	224	35	36	58

DISPOSITION of Board of Trade INSTRUMENTS.

In merchant ships -	68	8	430	—	—	283
In naval ships - -	—	—	81	—	—	—
In use at stations -	94	5	224	35	36	58
In store at M.O. - -	69	36	158	7	6	72
„ Gibraltar -	—	—	12	—	—	—
At Southampton agency -	2	2	7	—	—	8
„ Liverpool „ -	10	9	33	—	—	50
„ Hull „ -	3	—	18	—	—	12
„ Aberdeen „ -	1	—	20	—	—	12
Total, 1st Jan. 1870 -	247	60	983	42	42	495
Lost, &c. during 1869	19	5	192	10	10	81

APPENDIX V.

LIST of STATIONS reporting Meteorological Observations by Telegraph to the Office, with the Observers.

Thurso*	J. Trotter	—
Wick	J. Sandison	Postmaster.
Nairn	W. D. Penny	Schoolmaster.
Aberdeen	J. Gibson	Telegraph Superintendent.
Leith	T. Bolton	Telegraph Clerk.
Shields	T. Allaway	Do.
Scarborough	F. Shaw	Do.
Yarmouth	T. Robinson	Do.
Ardrossan	W. McNeil	Do.
Greencastle	J. Kelly	Do.
Holyhead	J. Andrews	Do.
Liverpool	S. Jones	Do.
Valencia	E. O'Sullivan	Do.
Cape Clear	G. Griffin	Do.
Roche's Point	W. Kennedy	Do.
Pembroke	J. C. Walker	Do.
Penzance	J. Senior	Do.
Plymouth	W. Pinchin	Do.
Portsmouth	T. Hardy	Do.
London†	Clerks in Meteorological Office	—
Heart's Content	J. Weedon	Telegraph Superintendent.

* This station has been added since 31st December 1869.
† Reports not sent by telegraph.

APPENDIX VI.

LIST of Persons, Places, &c. to which the Daily Weather Report is supplied.

Newspapers:

Daily News.
Echo.
Express.
Globe.
*Lloyd's Shipping List.
Observer.
*Pall Mall Gazette.
Shipping and Mercantile Gazette.
Standard (Morning and Evening).
Times (1st and 2nd edition).

For Exhibition at following Seaports:

Banff.
Belfast.
Blackpool.
Buckie.
Carnarvon.
Cromer.
Cullen.
Exeter (2 copies).
Great Grimsby.
Hayle.
Hull.
*Newquay.
Port Dinorwic.
Porthcawl.
Silloth.
Teignmouth.
Ventnor.

* Added since 31st December 1869.

Societies, &c.:

Association of Underwriters, Liverpool.
Do. Lloyd's.
Calcutta, Meteorological Committee.
Patent Office, London.
*Press Association.
Royal Society.
Scottish Meteorological Society.

Individual Observers, in co-operation, &c.:

Barnes, R. H., Kensington.
Griffith, Rev. C., Strathfield Turgiss.
Hoskins, Dr. S. E., Guernsey.
Mansell, J. C., Longthorns.
Moore, Dr. J. W., Dublin.
Richards, W. H., Penzance.
Tennent, R., Edinburgh.

Foreign Places:

Christiania, Meteorological Institute.
Constantinople, Imperial Meteorological Observatory.
Florence, Ministry of Agriculture.
Hamburg, North German Ocean Observatory.
Paris, Imperial Observatory.
„ Meteorological Observatory, Montsouris.
„ Meteorological Society.
„ Ministry of Marine.
St. Petersburg, Central Physical Observatory.
Upsala, University Observatory.
Utrecht, Royal Meteorological Institute.
Vienna, Imperial Observatory.
Washington, United States Naval Observatory.

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* Added since 31st December, 1869.

APPENDIX VII.

Telegraphic Weather Intelligence.

The following stations, having been approved by the Board of Trade, are supplied with telegraphic information of storms free of expense, and "drum" signals have been furnished to most of them, all further expenses attendant on the maintenance and repair of the apparatus being borne locally. The stations are situated, 70 in England, 26 in Scotland, and 10 in Ireland.

NORTH.	WEST.	SOUTH.	EAST.
Inverness.	Douglas.	Plymouth.	Tynemouth.
Nairn.	Maryport.	Teignmouth.	Sunderland.
Burghead.	Workington.	Exeter.	Middlesborough.
Lossiemouth.	Whitehaven.	Exmouth.	Redcar.
Buckie.	Barrow.	St. Helier } Jersey.	Whitby.
Portsoy.	Morecambe.	Gorey }	Filey.
Banff.	Fleetwood.	Cowes.	Withernsea.
Fraserburgh.	Blackpool.	Ventnor.	Hull.
Peterhead.	Lytham.	Portsmouth.	Goole.
Aberdeen.	Runcorn.	Littlehampton.	Grimsby.
Stonehaven.	Southport.	Brighton.	Boston.
Montrose.	Liverpool.	Hastings.	Lynn.
Broughty Ferry.	Queensferry.	Rye.	Cromer.
Dundee.	Mostyn.		Yarmouth.
Anstruther.	Holyhead.		Ipswich.
Alloa.	Port Penrhyn.		Harwich.
Grangemouth.	Carnarvon.		Chatham.
Granton.	Aberystwith.		Sheerness.
Leith.	Milford.		Faversham.
Fisherrow.	Pembrey.		Dover.
Dunbar.	Llanelly.		
Eyemouth.	Briton Ferry.		
	Porthcawl.		
	Penarth.		
	Cardiff.		
	Newport.		
	Weston-super-Mare.		
	Burnham.		
	Ilfracombe.		
	Barnstaple.		
Glasgow.	Fremington.		
Greenock.	Instow.		
Campbelton.	*Newquay.		
Girvan.	Hayle.		
	Pendennis.		
	Penzance.		
	Falmouth.		
	Belfast.		
	Howth.		
	Kingstown.		
	Dungarvan.		
	Youghal.		
	Queenstown.		
	Cork.		
	Passage.		
	Tralee.		
	Galway.		

* This station added since 31st December 1869.

APPENDIX VIII.

Circular No. 278. M. 8542.

Telegraphic Weather Information.

Sir, Board of Trade, 30 Nov. 1867.

I am directed by the Board of Trade to acquaint you, that they have been informed by the Meteorological Committee appointed by the Royal Society, that that Committee are now prepared to issue, free of cost, to ports or fishing stations which are accessible by telegraph, notice of serious atmospheric disturbance on the coasts or in the vicinity of the British Islands.

The conditions on which these notices will be issued, are as follows, viz. :—

They will be forwarded in each case as soon as information of the atmospherical disturbance shall have been received at the Meteorological Office, and the ports or fishing stations to which they are to be sent will be determined by the Board of Trade.

When the list of places to which notices may be sent has been determined by the Board of Trade, it will rest with the Meteorological Committee, in each case of atmospheric disturbance, to send notices to all or any of those places, as the circumstances of the particular case may appear to the Meteorological Office to be advisable.

When a telegraphic notice of atmospherical disturbance is received at one of the places named on the Board of Trade list, its receipt is to be made public by hoisting one of the late Admiral FitzRoy's drums, and the drum is to remain hoisted for 36 hours after the receipt of the telegraph message containing the notice.

One telegraphic notice implies that the drum is to remain hoisted for 36 hours, and no longer.

Should the Meteorological Committee think it necessary that a drum should remain hoisted for more than 36 hours in any case, they will send messages to that effect, and continue them from day to day so long as it appears desirable, or until the storm shall have abated.

If the authorities at any port or fishing station wish to receive intelligence of atmospherical disturbances, and will undertake to hoist the drum, subject to the conditions named, and subject to such regulations or directions as may from time to time be issued by the Meteorological Office, an application should be addressed to the Secretary to the Meteorological Committee, 2, Parliament Street, Westminster, S.W.,* in order that the necessary steps may be taken to place the name of the station on the Board of Trade list, and to provide the flagstaff and drum.

It is to be understood that where the place or station can pay for a flagstaff and drum they will be expected to do so, if a staff and drum are not already provided; and that where it is made to appear to the Board of Trade that no staff and drum are provided, and that the place is too poor to bear the expense, then the cost will be defrayed by the Meteorological Office, with the sanction of the Board of Trade.

But in all cases, whether the first cost of the flagstaff and drum are or are not borne by the local authorities, the local authorities must undertake to bear all subsequent charges connected with the hoisting of the signal, and the maintenance of the signal apparatus.

The only subsequent expense that will be defrayed by the Meteorological Office will be the charge for transmission of the notices of atmospherical disturbances.

I am, &c.

T. H. Farrer.

* The present address of the office is 116, Victoria Street, Westminster, S.W.

APPENDIX IX.

List of Places supplied with Fishery Barometers.

Those supplied during the years 1867–9 are distinguished by an asterisk.

Shetland Isles.—Sandsair, Lerwick.

Orkney Isles.—Burray.

Scotland, east coast.—Stroma, Staxigoe and Elzie, Sarclet, Lybster, Portmahomack, Cromarty, Avoch, Nairn, Burghead, Portessie, Port Knockie, Portsoy,* Whitehills, Gardenstown, Rosehearty, Pitullie, Findon, Portlethen, Arbroath, Broughty Ferry, St. Andrews, Crail, Cellardyke, St. Monance,* Burntisland, Newhaven.

England, east coast.—Berwick, Beadnell, North Shields, South Shields, West Hartlepool, Staithes, Scarborough, Filey, Flamborough, Bridlington Quay, Withernsea, Hull, Lynn, Wells, Gorleston, Harwich,* Brightlingsea,* Wivenhoe,* Margate, Deal, Kingsdown, Dover.

England, south coast.—Bognor,* Portsea, St. Helens and Ventnor* (Isle of Wight), Gorey (Jersey), Poole, Weymouth, Portland, Budleigh-Salterton, Cawsand, Mevagissey, Gorranhaven, Truro, Devoran, Penrhyn, Falmouth, Newlyn, Mousehole.

England, south-west coast.—St. Ives, Hayle, Port Isaac, Boscastle,* Fremington, Burnham, Highbridge.

Wales.—Swansea, Milford.

England, north-west coast.—Fleetwood, Morecambe, Maryport.

Isle of Man.—Port St. Mary,* Peel.

Scotland, south-west coast.—Port Patrick,* Stranraer.

Ireland, east coast.—Belfast, Bangor, Strangford, Ardglass, Dundalk, Howth, Kingstown.

Ireland, south coast.—Dungarvan, Kinsale.*

Ireland, west coast.—Valencia, Dingle, Tralee, Ballina,* Killybegs.*

Ireland, north coast.—Bunbeg, Burton Port, Dunfanaghy, Rathmullen.

Scotland, west coast.—Campbeltown,* Portree (Isle of Skye), Plockton.

Hebrides, Stornoway, Cromore, Babyle, Obb, Ness.

APPENDIX X.

LIST of PERSONS in the EMPLOYMENT of the METEOROLOGICAL COMMITTEE on December 31st, 1869, with their Occupations and Amount of Salary.

Name.	Duties.	Salary. Yearly. £ s. d.	Salary. Weekly. £ s. d.
Office.			
Robert H. Scott	Director of the office	800 0 0	—
J. S. Harding, jun.	Correspondence and accounts	170 0 0	—
J. S. Harding, sen.	Copying, accounts of stores, registry of documents, &c.	—	1 18 6
T. D. Bell		—	0 15 0
Commissionaire	Messenger	—	1 1 0
Land Meteorology (Observatories).			
S. Jeffery	Discussion of returns from observatories, and computations.	—	3 0 0
C. E. Burton		—	1 15 0
E. Magrath		—	1 5 0
J. P. Cutts		—	0 15 0
Land Meteorology (Telegraphy).			
F. Gaster	Preparation of weather reports, and computations.	130 0 0	—
F. Stevenson		90 0 0	—
F. Brodie		—	0 15 0
G. G. Francis		—	0 15 0
Ocean Meteorology.			
Capt. H. Toynbee	Marine Superintendent	400 0 0	—
W. Salmon	Examination of logs	220 0 0	—
R. Strachan	Care of instruments, and correspondence therewith connected	200 0 0	—
C. Harding	Examination of logs, and computations.	110 0 0	—
R. H. Curtis		90 0 0	—
J. Curtis		—	1 5 0
W. G. James		—	1 5 0
Balfour Stewart	Secretary to the Committee; Director of the Normal (Kew) Observatory	400 0 0	—
Rev. Thos. Kerr	Director of Valencia Observatory	250 0 0	—

APPENDIX XI.

Donations received during the Year 1869.

Presented by Societies, Institutions, &c.

Berlin - -	K. Statistische Bureau -	Preussische Statistik, Nos. XIV. and XIX. (Monthly means of pressure, temperature, &c. for the years 1867–8. See also Dove.)
Bombay - -	Colaba Observatory -	The normal winds of Bombay.
	,, -	Solar variations of magnetic declination at Bombay.
Calcutta - -	Meteorological Office -	Reports of the Meteorological Reporter to the Government of Bengal, 1867–8 and 1868–9.
	,, -	On the origin of a cyclone.
	St. Xavier's College -	Meteorological Register, January to June 1869.
Christiania -	Norske Meteorologiske Institut.	Meteorologisk Aarbog for 1867 and 1868.
	,, -	Meteorologiske Jagttagelser paa Christiania Observatorium, 1867.
	,, -	Meteorologiske Jagttagelser i Norge, January to November 1869.
	,, -	Meteorologiske Middelelser.
	,, -	Nogle Bemærkninger om Tordenveirenes Dannelse.
Cincinnati -	Observatory - - -	Inaugural Report, 30th June 1868, and Annual Report, 1st May 1869.
Constantinople -	Observatoire Impérial Météorologique.	Résumé des Observations Météorologiques, December 1868 to October 1869.
Copenhagen -	K. Danske Videnskabernes Selskab.	Forhandlinger, Nos. 6 and 7 for 1867; 1–4 for 1868; 1 for 1869.
Dorpat - -	Kaiserliche Universität -	Meteorologische Beobachtungen; years 1867–8.
	,, -	Über die Correction der Thermometer.
Dublin - -	Trinity College - -	Observations made at the Magnetical and Meteorological Observatory, Vols. I. and II.
Edinburgh -	Scottish Meteorological Society.	Journal, Vol. II., new series, Nos. 21–24. (See also Buchan.)
Florence - -	Ministero d' Agricoltura Industria e Commercio.	Meteorologia Italiana, September 1868 to September 1869.
	,, -	Supplement to ditto, p.p. 1–80 for year 1869, except p.p. 41–48.
Greenwich -	Royal Observatory - -	Report of the Astronomer Royal to the Board of visitors, 1869.
	,, -	Magnetical and Meteorological Observations, 1867.
Hamburgh -	Norddeutsche Seewarte -	Jahres-Bericht, 1868.
	,, -	Mittheilungen, No. I., Über die wissenschaftlichen Ergebnisse der ersten deutschen Nordfahrt von 1868.
		Ditto, No. II., Nordwest-deutscher Wetterkalender.
	,, -	Die Seewarte und (1) das National Einkommen (2) der Suez Canal (3) ihr Verhältniss zu den Navigationsschulen.
Kew - -	Observatory - - -	Report of the Kew Committee for the year 1868–9. (See also Stewart).

Lisbon - -	Observatorio do Infante D. Luiz.	Annaes, Vol. VI., July to November 1868, Vol. VII., December to February 1869.
London - -	Admiralty (Hydrographer)	South American Pilot, Parts I. and II.
	,, -	South Pacific Directory.
	,, -	Tide Tables for 1869 and 1870.
	,, -	Memoir of the Hydrographical Department.
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	,, -	Meteorology of England, Reports for four quarters, ended June 1869.
	Royal Astronomical Society	Monthly Notices, Vol. XXV., No. 1.
	Royal Institution - -	Proceedings, Vols. I.-IV. Vol. V., Nos. 45–50.
	Royal National Lifeboat Institution.	Journal, Vol. VII., Nos. 71–75.
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	,, -	Address delivered at the Anniversary Meeting, 30th November 1869, by Sir E. Sabine, K.C.B., President.
	Royal United Service Institution.	Journal, Vol. XIII., Nos. 53–55.
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Lyons - -	Commission Hydrométrique	Rapport, 1867.
Manchester -	Literary and Philosophical Society.	Proceedings, Vols. III.-VII.
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	,, -	Sulle variazioni periodiche del barometro nel clima di Milano.
Moncalieri -	Osservatorio del R. Collegio Carlo Alberto.	Bullettino Meteorologico, Vol. III., Nos. 11 and 12. Vol. IV., Nos. 1–9.
	,, -	Le Aurore Polari del 1869.
Munich - -	Königliche Sternwarte -	Wochenbericht, Nos. 180–233.
New Zealand -	(?)	Meteorological Report for New Zealand, by J. Hector, Esq., M.D., F.R.S.
Oxford - -	Radcliffe Observatory -	Results of Meteorological Observations, 1864–6.
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,,	Ministère de la Marine -	Annales hydrographiques, 4 Quarters of 1868. 3 ,, 1869.
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		Mémoire sur ,, ,,
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		Étude sur le régime des eaux du bassin de la Seine.
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		Étude sur le régime des eaux du bassin de la Seine pendant les crues du mois de Septembre 1868.
		Note rectificative sur les observations pluviométriques de Chateau-Chinon.
		Carte Hydrologique et Géologique du bassin de la Seine.
		Observations faites sur les petits cours d'eau. Mai 854–30 Avril 1868.
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,,	,, ,,	Annuaire de la Société Météorologique de France, Vols. I. to XV., Vol. XVI. Feuilles 6–19.
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,,	,, ,,	Notiz über die Nordlichte vom 15 und 16 April, und vom 3–14 Mai 1869.
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,,	,, ,,	Meteorological Summary for 1869.
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,,	,, ,,	On the Changes of Barometric Pressure, &c., from Observations in the seven years 1860–6. (By Sir E. Sabine.)
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	,, -	Normale fünftägige Wärmemittel für 88 Stationen, bezogen auf dem 20jährigen Zeitraum, 1848–67.
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Abbe, L.	„ Cincinnati.
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Beverley, Rev. A.	Meteorological Observations taken at Aberdeen Grammar School, 1868.
Blanford, H. F.	See Calcutta. Meteorological Office.
Bruhns, Dr. C.	Übersicht der Resultate aus den Meteor. Beobachtungen angestellt auf den K. Sächsischen Stationen, August 1868 to May 1869.
Buchan, A.	Note on the Determination of Heights, chiefly in the Interior of Continents, from Observations of Atmospheric Pressure.
„	The mean Pressure of the Atmosphere, and the prevailing winds over the Globe, Parts I. and II.
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Chase, Pliny E.	Tidal Rainfall of Philadelphia.
Coumbary, A.	See Constantinople.
Davis, Staff Com. J. E.	Notes on Deep Sea Soundings.
Denza, Sr.	See Moncalieri.
Deville, M. Ste. Claire	Sur les rétours périodiques des Phénomènes Météorologiques.
„	Documents relatifs aux aurores boréales. (See also Paris, Observatoire de Montsouris.)
Dove, Prof. H. W.	Über das barometrische Maximum in Januar 1869.
„	Über die nicht-periodische Veränderungen der Verbreitung der Wärme auf der Erdoberfläche. (See also Berlin.)
Freeden, Herr W. von	See Hamburg.
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Lamont, Dr. J. von.	„ Munich.
Le Gras, Captn. A.	„ Paris, Ministère de la Marine.
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Le Verrier, M.	„ „ Observatoire Impérial.
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Oettingen, Herr A. von -	See Dorpat.
Parks, W. - -	On the Tides of Bombay and Kurrachee.
Perry, Rev. S. J. - -	See Stonyhurst.
Petermann, Dr. - -	Die wissenschaftlichen Ergebnisse der ersten deutschen Nordfahrt.
Prestel, Dr. - -	Das Gesetz der Winde.
Prettner, Dr. J. - -	Meteorologische Beobachtungen zu Klagenfurt. December 1868 to November 1869.
Sabine, Sir E. - -	Pendulum and other Experiments. (See also note at end, and London Royal Society.)
Sands, Commodore -	See Washington. United States Naval Observatory.
Savy, M. B. - -	Densité Salure et Courants de l'océan Atlantique.
Schaub, Dr. - -	„ Lorenz.
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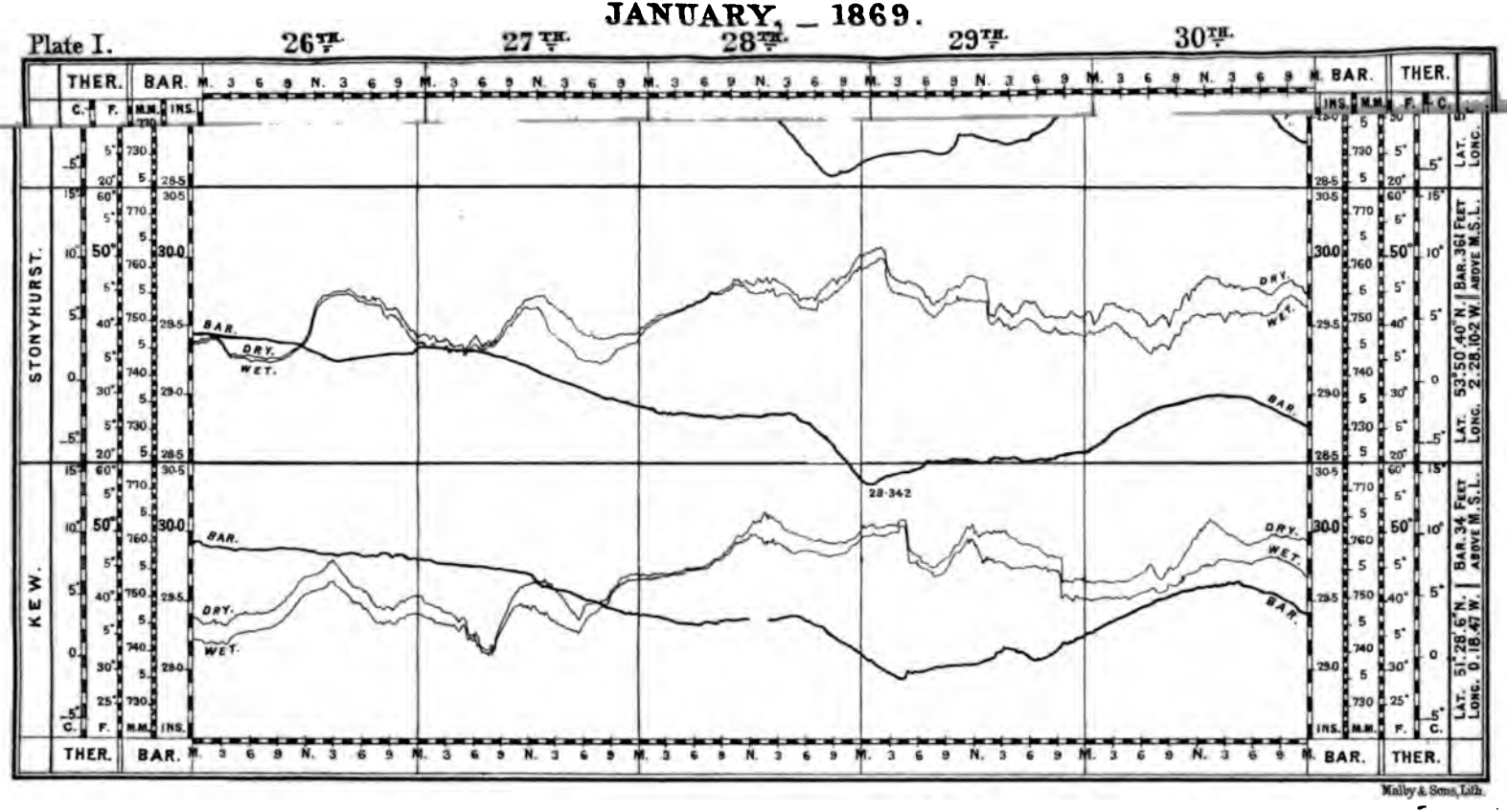
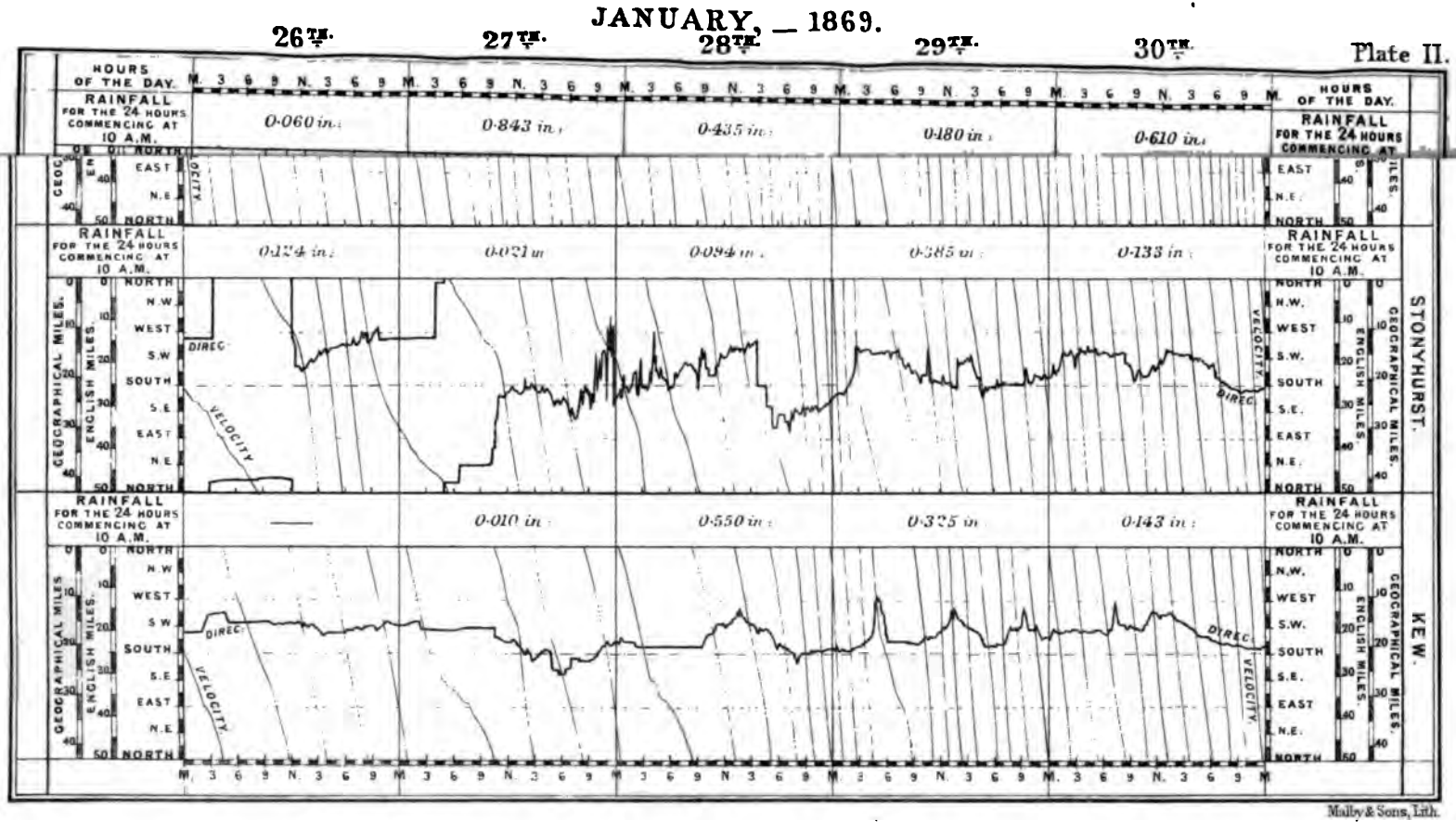
„ - -	Über den jährlichen Gang des Barometers.
Secchi, Padre A. - -	See Rome.
Silveira, Sr. Da. - -	„ Lisbon.
Stewart, Dr. - -	Results of a Preliminary Comparison of certain Curves of the Kew and Stonyhurst declination Magnetigraphs. (See also Kew.)
„ - -	Description of a Pendulum Electrograph now in use at the Melbourne Observatory.
„ - -	Determination of the dip at some of the Principal Observatories in Europe.
„ - -	On the re-appearance of some Periods of declination Disturbance at Lisbon during two, three, or several days.
„ - -	Preliminary Investigation into the laws regulating the Peaks and Hollows exhibited in the Kew Magnetic Curves.
„ - -	Results of Magnetical Observations made at Ascension Island, by Lieut. Rokeby, R.M.
„ - -	Researches on Solar Physics. No. III. By Messrs. De La Rue, Stewart, and Loewy.
„ - -	Remarks on Meteorological Reductions, with especial reference to the Element of Vapour.
Wild, M. - - -	See St. Petersburg.
Williamson, R. S. - -	On the use of the Barometer on Surveys and Reconnaissances.
Wolf, Dr. - - -	See Zurich.

NOTE.—The office is also indebted to Sir E. Sabine for numerous works by various authors, and for the Results of Meteorological and Magnetical Observations made at the Colonial Observatories, &c.



Specimen Plate Barograms and Thermograms, (Dry & Wet.)



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LIST OF PUBLICATIONS, &c.

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OFFICIAL.

No. 1. Report for 1867. Presented to Parliament. 1*s.*

2. Instructions for Meteorological Telegraphy.

3. Fishery Barometer Manual. 6*d.*

4. Charts of Surface Temperature, South Atlantic Ocean. 2*s.* 6*d.*

5. Report for 1868. Presented to Parliament. 5*d.*

6. Report for 1869. Presented to Parliament.

7. Quarterly Weather Report, No. I., January to March 1869. 5*s.* [Published by Stanford, Charing Cross.]

NON-OFFICIAL.

No. 1. Report to the Committee on the Connexion between Strong Winds and Barometrical Differences.—By Robert H. Scott, Director of the Office. 6*d.*

2. Report to the Committee on the Meteorology of the North Atlantic.—By Captain H. Toynbee, Marine Superintendent. 1*s.*

3. Report to the Committee on the Use of Isobaric Curves.—By Captain H. Toynbee, Marine Superintendent. 1*s.*

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The Annual Reports may be obtained of all Parliamentary Booksellers.

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For Her Majesty's Stationery Office.

REPORT

OF THE

METEOROLOGICAL COUNCIL

TO THE

ROYAL SOCIETY,

For the Year ending 31st of March 1890.

Presented to both Houses of Parliament by Command of Her Majesty.

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THE METEOROLOGICAL COUNCIL,

1889–90.

Lieutenant-General Richard Strachey, R.E., C.S.I., F.R.S., Chairman.

Mr. Alexander Buchan, M.A., LL.D., F.R.S.E.

Professor George Howard Darwin, M.A., LL.D., F.R.S.

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Mr. Edward J. Stone, M.A., F.R.S.

Captain William J. L. Wharton, R.N., F.R.S., Hydrographer of the Admiralty.

REPORT

OF THE

METEOROLOGICAL COUNCIL

TO THE

ROYAL SOCIETY,

For the Year ending March 31, 1890.

THERE has been no change in the Council during the year. The executive officers are as in the last Report:— Introductory.

Mr. R. H. Scott, M.A., F.R.S., Secretary.
Nav.-Lieut. C. W. Baillie, R.N., F.R.A.S., Marine Superintendent.

In the last Report it was mentioned that the Treasury had intimated to the Council that it was desirable to reduce the cost of printing for the Office; the action which has been taken to follow out this suggestion will lead to a considerable saving in the expense of the publications of the Office. The correspondence will be found in Appendix I. (p. 57).

The present Report is arranged under three headings:—

I. Ocean Meteorology.
II. Weather Telegraphy.
III. Land Meteorology of the British Isles.

PART I.

OCEAN METEOROLOGY.

Collection of Information.—The practice followed by the Office with reference to observers at sea, as described in former Reports, remains unchanged. Collection of information.

Appendix II. (p. 60) contains a list of all the observers who during the past year have contributed logs classed as "excellent." Several of these observers have regularly co-operated with the Recognition of "excellent" observers.

Recognition of "excellent" observers.

Office for many years. The names which appear in the list for the first time are as follow:—

Captain's Name.	Ship.
Angus, T. S.	S.S. "Canton."
Atkinson, G. W.	S.S. "Kaisar-i-Hind."
Cameron, Sub-Lieut. A. C. L., R.N.	H.M.S. "Stork."
De Horne, M.	S.S. "Rohilla."
Docherty, H.	"Baron Colonsay."
Drenning, W. B.	S.S. "Mira."
Garnsworthy, T.	S.S. "Ardancorrach."
Gillies, W.	S.S. "Medway."
Helby, Lieut. H. W. H., R.N.	H.M.S. Myrmidon."
Mitchell, G.	S.S. "Trinacria."
Owen, O.	S.S. "Cordelia."
Pasifull, E. J.	"Rahane."
Pope, J.	S.S. "Derwent."
Pullen, Commr. T. F., R.N.	H.M.S. "Stork."
Saul, J.	"Coronilla."
Sibery, H., R.N.R.	S.S. "Clan Cameron."
Stewart, A.	"County of Selkirk."
Thearle, J.	S.S. "Lennox."
Thompson, Lieut. H., R.N.	H.M.S. "Rambler."
Trevor-Roper, Dr. G. D., R.N.	H.M.S. "Stork."
Worrall, W. A.	"Camana."

Proportion of "excellent" to total number of logs received.

The total number of logs received in the year ending March 31, 1890, is 172, of which 136, or 79 per cent., have been classed as "excellent," being nearly the same per-centage of "excellent" logs as in last year.

The average number of logs received annually during the five years, 1884–88, was 186, of which the per-centage of "excellent" logs was 75.

The Council take this opportunity of expressing their best thanks to the observers who have assisted them during the past year.

They regret to have to announce the deaths of four of their observers; Capt. Hugh Campbell, ship "Holkar," who had kept 7 "excellent" logs; Capt. A. Hart Dyke, S.S. "La Plata," who had kept 2; Capt. W. Hughes, ship "Bolan," who had kept 9; and Comr. T. F. Pullen, H.M.S. "Stork," who had recently begun to observe.

Appendix III. (p. 63) gives a list of meteorological logs and of meteorological reports from stations abroad, received at the Office during the year.

Districts from which observations are obtained.

The following summary of the voyages of the ships observing for the Office shows the districts from which observations were received during the year:—

To Baffin's Bay or Greenland	2
„ North America, East Coast	28
„ „ „ West „	9
Off East Coast of North America	1
To West Indies	23

To South America, East Coast - - - -	13	Districts from which observations are obtained.
„ „ „ West „ - - - -	9	
„ Australia and New Zealand, viâ Cape of Good Hope	23	
„ „ „ „ Suez - -	1	
At Australian stations - - - - -	6	
To India, viâ Suez - - - - -	11	
„ India, viâ Cape of Good Hope - - -	18	
„ China, viâ Suez - - - - -	6	
„ Cape of Good Hope - - - -	10	
„ West Coast of Africa - - - -	1	
„ East „ „ - - - -	1	
Between British Ports - - - - -	6	
To Mediterranean Ports - - - -	5	

Red Sea.

Red Sea Charts.—The discussion of the Meteorology of the Red Sea, mentioned in last Report, has now been completed, and the charts are nearly ready for engraving.

Cape Guardafui.

Cape Guardafui Charts.—Numerous additions have been made to these charts, which illustrate the winds, sea temperature, and currents for the entire year, and they are now being prepared for the engraver.

The Aden Cyclone.

The Aden Cyclone of June 1885.—The synchronous daily charts of two storms that occurred in this month have been completed, and will at once be engraved. They cover a period of six weeks, and are the first daily charts of this description that have been prepared for the Arabian Sea.

Indian Ocean Cyclones.

Cyclone Tracks in the Southern Indian Ocean.—These charts, which as stated in former reports have been compiled from the data furnished by Dr. Meldrum, showing the frequency and tracks of cyclones for nearly 20 years, arranged according to months, are now in the press, and will be issued immediately. Dr. Meldrum's original charts, showing the yearly tracks, will also be engraved and accompany those prepared in the Office.

Barometrical Pressure Charts.

The Charts of Barometrical Pressure for the Oceans.—The two charts mentioned in last Report, one exhibiting the mean barometrical pressure for the year, and the other indicating the extent of range in the barometrical readings taken in different districts, have been issued.

Current Charts

Current Charts for the Atlantic, Pacific, and Indian Oceans.—The whole of the data relating to currents contained in the Office logs have been entered on the charts, and the Remark Books of H.M. ships are now being dealt with. The currents recorded in the logs of H.M. ships between the years 1830 and 1862 will next be taken in hand. The information obtained from these sources is especially valuable as supplying currents near the land, and for parts of the sea seldom traversed by ships of the Mercantile Marine.

Southern Ocean.

Southern Ocean.—The discussion of the meteorological information available for the region from the Cape of Good Hope to New Zealand, referred to in the last Report as the future marine work of the Office, has been commenced. The currents, winds, pressure, and temperature of the air and sea are dealt with, and the occurrence of ice and of whales is noted. The information contained in the Office logs will be supplemented by information

available from any extraneous sources which are likely to be serviceable.

Foreign Stations. Malden Island.

Supply of Instruments to Stations in the Pacific, &c.—The existing information as to the occurrence of cyclones or other storms in the Pacific is very incomplete, and the want of such information was felt on the occasion of the Samoa cyclone, March 20, 1889. With the view of obtaining further observations, instruments have been supplied on loan to Malden Island, lat. 4° 2′ S., long. 154° 58′ W., and others will be sent shortly to

New Guinea.

Port Moresby, in New Guinea. Besides these steps the co-operation of the French Meteorological Department has been solicited in the hope that data may be procured from New Caledonia and the Society Islands.

Houtman's Abrolhos Islands.

A meteorological outfit has also been supplied to a station in the Houtman's Abrolhos Islands, in the South Indian Ocean, off Geraldton, in West Australia.

St. Domingo.

Observations at Sanchez, Samaná Bay, St. Domingo.—The observations made by the late Dr. W. Reid during the years 1886, 1887, and 1888, are now passing through the press, and the volume will appear shortly.

Stock of Instruments belonging to the Office.

Supply and Stock of Instruments.—In Appendix IV. (p. 69) is given a list of the meteorological instruments supplied by the Office to ships in the Royal Navy during the year, with a statement for the 31st March 1890 of the stock and distribution of the instruments standing on the books to the account of the Admiralty.

Appendix V. (p. 70) gives similar information with regard to the disposal of the other instruments belonging to the Office, remaining in store, or which have been supplied to the Mercantile Marine, observatories, telegraph offices, &c.

PART II.

Weather Telegraphy and Forecasts.

Administrative.

There have been no serious interruptions of telegraphic communication during the year.

The following have been the changes in the reporting stations and staff:—The station at Barrow-in-Furness has been discontinued since the end of 1889; at Dungeness, Mr. Batton has succeeded Mr. P. Curnow; and at Scilly, Mr. A. Hicks has been appointed to replace Mr. W. Thomas, who died in March 1890.

A list of the telegraphic reporting stations, British and Foreign, is given in Appendix VI. (p. 71).

The work in this branch of the Office continues to increase. The Daily and Weekly Weather Reports, in particular, have been extended and improved.

Inspection of the Stations.

Inspection of the Telegraphic Reporting Stations.—The telegraphic reporting stations have been inspected during the year, in England by Mr. Ley, in Scotland by Mr. Buchan, and in Ireland

and Wales by Mr. Scott. The reports submitted by the Inspectors to the Council, which are printed in Appendix VII. (p. 72), show that the efficiency of the service continues to be satisfactorily maintained.

Discussion of the reports.

Discussion and Publication of the Information received.—The practice of the Office in collecting, discussing, and disseminating the meteorological information received by telegraph is described in Appendix VIII. (p. 86). The Daily Weather Report has appeared regularly during the year; for details see Appendix VIII. It is distributed free of cost as follows:—To newspapers, seven copies; to seaports, for public exhibition, 71 copies; to Government offices and public institutions, 66 copies; to correspondents of the Office, 73 copies; and to foreign meteorological establishments, 46 copies. Nearly 200 copies are issued regularly to subscribers.

The Weekly Weather Report, with its Monthly Appendices, has also appeared regularly; for particulars of this publication see Part III., p. 17.

Display of information in front of the Office.

Public display at the Office of the State of the Weather on British Coasts.—With a view to the earliest possible supply to the public of the latest information as to the weather received from the principal points on the coast, the Council have arranged for the display in a conspicuous manner on the front of the Meteorological Office, 63, Victoria Street, of the substance of the reports received by telegraph at 9.30 a.m. and 3 p.m., every week day, of the state of the weather and sea at the following stations: Yarmouth, Dungeness, the Needles (Hurst Castle), Scilly, Holyhead, and Valencia.

Forecasts.

Weather Forecasts.—Forecasts are, as heretofore, prepared three times a day, namely, at 11 a.m., at 3.30 p.m., and 8.30 p.m. The Forecasts prepared at 11 a.m., on the information derived from the 8 a.m. reports, refer to the probable weather between noon on the day of issue and noon on the following day. They are publicly exhibited in several places in London,* and are supplied to the afternoon editions of the newspapers. The 3.30 p.m. Forecasts are employed for storm warnings only, excepting in the hay harvest season, when they are issued as subsequently explained. The forecasts at 8.30 p.m. are specially prepared for publication in the morning newspapers, but all the forecasts are available for the information of anyone who applies for them at the Office.

Inquiries at the Office.

The inquiries received through the Post Office for special forecasts during the year amounted to 52, and the personal applications to 29. The rules of the Office relating to such inquiries are stated in Appendix VIII. (p. 91).

Testing of the Forecasts.

The results of a comparison of the Forecasts issued at 8.30 p.m. during the year, with the weather actually experienced are given

* Viz., in the City, at the Mansion House, Lloyd's Rooms, Messrs. R. & J. Beck's, Cornhill, and Messrs. de la Rue & Co.'s, Bunhill Row; in the West End, in the Libraries of the House of Lords and House of Commons, at Messrs. Elliot's, St. Martin's Lane; Messrs. Stanford's, Charing Cross; Messrs. Negretti & Zambra's, Regent Street; and Messrs. Pastorelli's, New Bond Street.

of s. in Appendix X. (p. 94). The following summary shows the successes and failures over the whole United Kingdom, estimated as explained in that Appendix. The results were best, 87 per cent., for England South, and worst, 76 per cent., for Scotland West.

SUMMARY of RESULTS of 8.30 p.m. FORECASTS, 1889–90.

Districts.	Per-centages.				Total per-centage of Success.
	Complete Success.	Partial* Success.	Partial* Failure.	Total Failure.	
SCOTLAND, N. - -	50	31	12	7	81
„ E. - -	51	31	12	6	82
ENGLAND, N.E. - -	46	35	12	7	81
„ E. - -	51	32	11	6	83
MIDLAND COUNTIES -	51	29	15	5	80
ENGLAND, S. - -	54	33	10	3	87
SCOTLAND, W. - -	45	31	14	10	76
ENGLAND, N.W. -	48	30	13	9	78
„ S.W. -	51	31	10	8	82
IRELAND, N. - -	48	33	11	8	81
„ S. - -	46	32	12	10	78
Summary - -	49	32	12	7	81

* Note "partial" implies "more than half."

f s. The following table shows for each year from 1881 to 1889, inclusive, the per-centages of complete and partial success of the Forecasts issued at 8.30 p.m. for the whole year. Without questioning that improvements may be hoped for as a result of further research, it is doubtful how far greater success is likely to be attained so long as, at present, no information can be obtained concerning atmospheric changes going on over the Atlantic beyond the west coast of Ireland.

PER-CENTAGES of RESULTS of FORECASTS for the whole of the BRITISH ISLES.

Year.	Complete Success.	Partial, *i.e.*, more than Half Success.	Total Success.
1881 - -	34	42	76
1882 - -	43	37	80
1883 - -	48	33	81
1884 - -	50	31	81
1885 - -	50	34	84
1886 - -	49	31	80
1887 - -	52	32	84
1888 - -	51	31	82
1889 - -	49	32	81
Average - -	47	34	81

Hay Harvest Forecasts.

Hay Harvest Forecasts.—The Council renewed in 1889 the offer made in previous years to the Royal Agricultural Society, the Royal Dublin Society, and the Highland and Agricultural Society to send Daily Forecasts *gratis* during the haymaking season to a number of observers selected by those Societies, on two conditions, viz., that the information should be made known as widely as possible, and that a record of the weather actually experienced should be sent weekly to the Office. The Societies accepted the proposal, and the Forecasts were issued as shown in the following table:—

LIST of those who received HAY HARVEST FORECASTS in 1889.

Districts.	To whom sent.	Address.
0. SCOTLAND, N.	Rev. Dr. Joass	Golspie.
	Major Smith	Munlochy, Inverness.
1. SCOTLAND, E.	J. Whitton	Glamis, by Forfar.
	G. Murdoch	Rothiemay, Huntly.
	C. L. W. Forbes	Aberfeldy.
2. ENGLAND, N.E.	Sir J. Wilson	Chillingham Barns, Chatton, Northumberland.
	J. Turner	The Grange, Ulceby.
3. ENGLAND, E.	W. Birkbeck	High House, Thorpe, Norwich.
	Sir J. B. Lawes, Bt., and J. H. Gilbert, Ph.D.	Rothamsted, Harpenden.
	J. Fergusson*	Brettenham Manor, Thetford.
4. MIDLAND COUNTIES	Royal Agricultural College.	Cirencester.
	E. E. Harcourt-Vernon	Grove Hall, East Retford.
5. ENGLAND, S.	C. Whitehead	Barming House, Maidstone.
	E. P. Squarey	The Moot, Downton, Wilts.
	G. M. Allender	Stammerham, Horsham.
	M. J. Sutton	Reading.
6. SCOTLAND, W.	W. Calder	Castle Hill, Dalreoch, Dumbarton
	M. J. Stewart, M.P.	Ardwell, Stranraer.
	J. S. R. Ballingal	Eallabus House, Islay.
7. ENGLAND, N.W.	G. W. Wray	Leyburn, Yorkshire.
	The Earl of Derby, K.G.	Knowsley Hall, Prescot.
8. ENGLAND, S.W.	Colonel J. B. Turbervill	Ewenny Priory, Bridgend, Glamorganshire.
	The Earl of Ducie	Tortworth, Gloucestershire.
	T. Dyke	Long Ashton, Clifton, Bristol.
	R. Neville Grenville	Butleigh Court, Glastonbury.
9. IRELAND, N.	E. F. Farrell	Moynalty, Co. Meath.
10. IRELAND, S.	D. A. M'Cready	Larchvale, Moneygall, King's Co.
	D. A. Milward	Lavistown, Kilkenny.
	W. Talbot Crosbie, D.L.	Ardfert Abbey, Tralee, Co. Kerry.

* Mr. Fergusson is a subscriber for these Forecasts.

Hay Harvest Forecasts.

The issue of the forecasts commenced on June 11th with those for the South and East of England, and were continued for about five weeks, ending on the 3rd of August over the greater part of Scotland, and a week later in Ireland.

The general result of the issue of these forecasts, shown by the subjoined table, has been prepared solely from the reports of the above-mentioned gentlemen, and is entirely independent of any estimate formed within the Office itself :—

SUMMARY of RESULTS.—HAY HARVEST FORECASTS, 1889.

Districts.	Names of Stations.	Percentages.				
		Complete Success.	Partial Success.	Partial Failure.	Total Failure.	Total percentage of Success.
SCOTLAND, N. -	Munlochy and Golspie - - -	57	33	10	—	90
„ E. -	Aberfeldy, Rothiemay, and Glamis -	51	31	13	5	82
ENGLAND, N.E. -	Chatton and Ulceby - - -	67	26	7	—	93
„ E. -	Rothamsted, Thorpe, and Thetford -	64	29	7	—	93
MIDLAND COUNTIES	Cirencester and East Retford - -	61	34	3	2	95
ENGLAND, S. - -	Downton, Horsham, Maidstone, and Reading.	60	30	10	—	90
SCOTLAND, W. -	Stranraer, Islay, and Dumbarton -	52	30	14	4	82
ENGLAND, N.W. -	Leyburn and Prescot - - -	53	30	12	5	83
„ S.W. -	Tortworth (Gloucestershire), Clifton, Bridgend (Glamorganshire), and Glastonbury.	50	40	9	1	90
IRELAND, N. - -	Moynalty - - - - -	50	40	7	3	90
„ S. - -	Moneygall, Kilkenny, and Tralee -	56	29	10	5	85
	Mean for all districts, 1889 - -	57	32	9	2	89
	„ „ 1888 - -	49	35	11	5	84

These figures show that the forecasts for 1889 were five per cent. better than those for 1888, and indicate the highest proportion of success that has ever been reached.

The largest general per-centage (95) was attained in the Midland Counties, and the lowest (82) was in Scotland East and West.

Major Smith and Messrs. Birkbeck, Fergusson, Squarey, and Sutton all gave independent testimony to the correctness of the forecasts.

In addition to the above, telegrams were sent to several other gentlemen at their own cost.

The funds at the disposal of the Council will not admit of extensive gratuitous distribution of Hay Harvest Forecasts, but now that the Board of Agriculture has been organised, the Council propose in the course of the current year again to suggest the advisability of a wider distribution of these Forecasts, their former reference to the Privy Council on the subject having led to no result.

Supply of Forecasts to the Fleet during the Manœuvres.—At the request of the Admiralty daily forecasts were supplied to the Commander-in-Chief of the "A" Fleet during the continuance of the Manœuvres in 1888 and 1889.

Information as to Forecasts supplied to the United States.—In the month of April 1889 inquiries as to the practice of the Office

in the preparation and issue of forecasts were received from the Chief Signal Office, Washington, and the Council furnished replies. The correspondence will be found in Appendix IX., p. 92.

Storm warnings.

Storm Warnings for the Coasts of the United Kingdom.—In Appendix XI. (p. 95) are given the names of the stations furnished with signals for Storm Warnings, in accordance with Circular 717 of the Board of Trade issued in February 1874.

These stations were, at the end of March 1890, 153 in number, situated:—

72 in England, 16 in Wales, 44 in Scotland, 15 in Ireland, 3 in the Isle of Man, and 3 in the Channel Islands.

With a view of adding to the efficiency of these warnings a revision of the districts in which the stations are arranged has been made, and further measures will be taken to improve the record of storms on the coasts by means of which the utility of the warnings will be better checked.

A comparison has been made in the Office between the warnings issued in 1889 and the weather experienced on our coasts, the warnings being tested by the method explained in Appendix VIII. (p. 92). The results of this comparison are shown in the following tables:—

RETURN of the RESULT of the COMPARISON between the WARNINGS ISSUED and the WEATHER EXPERIENCED in 1889.

Coasts.	Total No. of Orders to hoist and repetitions.	Warnings justified by subsequent Gales. Force 8 and upwards.	Warnings justified by subsequent strong Winds. Forces 6 and 7.	Warnings not justified by subsequent Weather.	Warnings late. Force 9 reached at two Stations before issue.	Warnings partially late. Force 9 reached at one Station before issue.	Warnings in Error owing to telegraphic mistakes.	Storms for which no Warning was issued.
Ireland, South -	43	24	12	5	1	1	—	Feb. 2–3.
„ East -	44	13	20	11	—	—	—	Feb. 2–3.
Scotland, East -	39	25	9	5	—	—	—	Jan. 18, Feb. 2–3. Mar. 26*, Sept. 28.
„ West -	39	16	15	8	—	—	—	Feb. 2–3.
England, North-west	42	25	11	6	—	—	—	Feb. 2–3, Mar. 26, Sept. 28, Nov. 15.
„ West -	37	14	18	5	—	—	—	Feb. 2–3, Nov. 25.
„ South-west	36	18	14	2	1	1	—	—
„ South -	30	19	8	2	—	1	—	Nov. 25.
„ South-east	28	11	11	5	—	1	—	Nov. 25.
„ East -	35	13	7	14	—	1	—	—
Totals - -	373	178	125	63	2	5	—	
Per-centages -	—	47·7	33·5	16·9	0·5	1·4	—	

* These gales were felt only to the northward of Aberdeen.

NOTES as to GALES in 1889 for which WARNINGS were not issued.

Jan. 18th.—A brief but severe gale from westward, felt in Caithness and the Shetlands. Apparently caused by a small depression of which we could have no knowledge, but secondary

Notes as to gales for which warnings were not issued.

to a larger system situated over Lapland. Gale confined to extreme northern stations.

Feb. 2–3.—A severe and wide-spread gale from west to north-west, caused by a large and deep depression which on Feb. 1 appeared to be moving eastwards towards Norway. At 6 p.m., 1st, barometer had begun to rise in Ireland as though the worst was past, but in the following night the storm suddenly took a southerly course, and passing quickly down our eastern coast, caused the gales mentioned. At 8 a.m., 2nd, it was too late to hoist any signals.

March 26th.—Fresh to strong north-westerly gale in north and east of Scotland, caused by small depression advancing suddenly from north-westward early on 26th, in rear of, and secondary to, a larger system which had moved from the Shetlands towards Norway. By 8 a.m., 26th, it was too late to hoist any warning signals.

Sept. 28th.—North-westerly gale in north of Scotland and north-west England. At 8 a.m., 28th, a depression lay off the west of Norway, and appeared to be moving south-eastwards. Subsequently it took a much more southerly course, while pressure actually increased on our western coasts; a gale was thus produced, without being expected. At 8 a.m., 29th, centre of depression was over Holstein.

Nov. 25th.—Strong south-westerly gale on western, southern, and south-eastern coasts of Great Britain, caused by a depression which lay over Ireland at 6 p.m., 24th. Of the depth of this disturbance we had no knowledge owing to insufficient information, the 24th being a Sunday. Available reports showed only a "V"-shaped system of moderate intensity, but the Parsonstown report next morning showed that the "V" contained a well-formed disturbance which caused the gales referred to.

Comparison of results for 1889 with previous years.

The following table contains a comparative statement of the storm warnings and their results in 1889, and in the ten preceding years. It will be seen that the total per-centage of warnings justified is 81·2, being 2·7 less than that for the preceding year:—

Years.	Total No. of Warnings issued.	Warnings justified by subsequent Gales.	Warnings justified by subsequent strong Winds.	Total Warnings justified.	Warnings not justified by subsequent Weather.
		p.c.	p.c.	p.c.	p.c.
1879	509	50·5	25·1	75·6	20·6
1880	390	58·2	24·6	82·8	13·3
1881	454	58·6	23·3	81·9	14·8
1882	503	61·4	21·1	82·5	14·9
1883	610	56·2	21·6	77·8	20·8
1884	461	66·4	20·0	86·4	12·1
1885	591	55·3	24·0	79·3	19·5
1886	542	55·3	26·9	82·2	15·9
1887	472	55·5	26·1	81·6	16·4
1888	539	55·3	28·6	83·9	14·3
1889	373	47·7	33·5	81·2	16·9

The Washington Maritime Conference.—A proposal to introduce international uniformity in the existing systems of Storm Warnings in various countries was included in the Programme for this Conference, and in the month of November the Council were consulted by the Board of Trade as to the representation of this country at Washington by a special delegate with reference to this question. The reply of the Council was not favourable to the nomination of such a delegate. The correspondence will be found at Appendix XII., p. 97. Washington Maritime Conference.

Proposal for a Meteorological Station at Bermuda.—In the month of July an inquiry was received from the Board of Trade, as to the probable cost of the maintenance of a telegraphic reporting station at Bermuda. The Council, in their reply, strongly supported the establishment of such a station, and stated that the cost of such stations in these islands was very moderate. The correspondence will be found at Appendix XIII.. p. 99. Proposed station at Bermuda.

Fishery Barometers.—To add to the means of obtaining warnings of stormy weather by the sea-going population, barometers were many years ago supplied by the Board of Trade on loan to fishing villages and other places on the coast, to be set up for public information. The whole number of stations supplied by the Office with these instruments is 177. Of these 59 are in England, 6 in Wales, 49 in Ireland, 59 in Scotland, 3 in the Isle of Man, and 1 in Jersey. The list is given in Appendix XIV., p. 102. Fishery barometers.

The inspection of the Fishery Barometers in England and Ireland has been continued during the past summer, the Hon. R. Abercromby taking the east of England, while Captain Toynbee visited the north of Ireland, from Donegal Bay round to Dundalk.

In almost all cases the instruments were found to be in good order, and they seemed to be valued by the fishermen in each locality. Whenever possible, the opportunity of the inspection was taken to impart instruction in the use of instruments in connexion with weather observations.

Simultaneous Observations.—The Office has continued its co-operation in the system of International simultaneous observations, taken at Greenwich mean noon, as explained in former Reports, which was organised in 1874, at the request of the Chief Signal Officer of the United States. Simultaneous observations.

The number of these observations which have been received during the year from the Royal Navy has been 3,880, and from the Mercantile Marine, 6,300.

PART III.

Land Meteorology of the British Isles.

Observatories and Stations.—The observations of the climate of the British Isles, which are received by the Office from certain

stations, may be arranged in five classes, according to the degree of completeness with which they are made.

Self-recording observatories.

1. The Observatories furnished with self-registering instruments by which all the principal meteorological phenomena are recorded continuously. These alone afford the materials necessary for the study of the periodic variations of the meteorological elements.

Anemographic stations.

2. Anemographic stations furnished with instruments registering the wind only. The records from these stations relate rather to weather as distinguished from climate, and are especially important in connexion with storms. They are often useful in affording evidence available in courts of law with respect to collisions at sea, and damage done by wind.

Stations of Second Order.

3. Stations of the Second Order furnishing climatological information from eye observations taken twice a day. The observers at these stations are all volunteers.

Telegraphic Reporting Stations.

4. The Telegraphic Reporting Stations, at which the observations are taken by eye, but supplemented in some cases by self-recording aneroids, &c., supply the material upon which the daily weather reports and forecasts are based. The hours of observation at these stations are determined by the requirements of the telegraphic system, as explained in Part II., but the data which they furnish are also utilized to afford climatological information for parts of the country where Stations of the Second Order do not exist.

Extra stations.

5. Extra stations furnishing returns with less completeness and detail than those of Class 3.

Sunshine stations.

A continuous record of the amount of bright sunshine is received from 39 stations in the British Isles, of which some are first or second order stations, whilst from others the sunshine record is alone received. See Appendix XV., p. 103.

A fuller account of these several stations and of the methods employed by the Office in dealing with their records will be found in Appendix XVI., p. 104.

Documents received.

Appendix XVII., p. 108, contains a list of all documents relating to the land meteorology of the British Isles received at the Office during the year.

Regulation of Observatory work.

Regulation of Work at principal Observatories.—The regulations for the management of the self-recording instruments have been carefully revised. They will be found in Note A., p. 24. The experience of nearly 20 years has shown that in all essentials the instruments are thoroughly satisfactory, and that very little alteration was required in the instructions originally issued for their use, which are contained in the Report of the Office for 1868.

Inspection of Stations.

Inspection of the Stations.—The self-recording observatories and the anemographic stations (Classes 1 and 2), as well as the Telegraphic Reporting Stations (Class 4), are regularly visited each year by the Inspectors of the Office. The extra stations (Class 5) are inspected as opportunity offers. Of the Stations of the Second Order (Class 3), some belong to the Royal Meteorological Society; these are visited by an Inspector appointed by that Society, an allowance being made by the Office toward the cost of the

inspection, in accordance with the recommendation of the Treasury Committee (1877); and some belong to the Scottish Meteorological Society. The remaining Stations of the Second Order are visited at least once in every two years by the Inspectors of the Office. The Superintendent of the Kew Observatory, Mr. G. M. Whipple, and his chief assistant, Mr. T. W. Baker, are specially employed to inspect and report on the self-registering apparatus, and on the photographic processes at the observatories. Extracts from the Reports of the Inspectors are given in Appendix VII., p. 72. Inspection of stations.

Information supplied to the General Register Office, Dublin.—Reports from eleven of the Irish stations of the Office have been regularly supplied to the Registrar General for Ireland, for his Weekly and Quarterly Returns. Reports supplied to Registrar General for Ireland.

Quarterly Weather Report.—Part I. of the volume for 1880 has been issued, and Part II. is in the press. On the final completion of this volume the issue of the Quarterly Weather Report with the reproduction of the continuous records from the seven observatories, comes to an end. Publications.

The following is a list of the volumes which have already appeared or are in process of issue, with the dates of their publication:—

Quarterly Weather Reports.

Year.	Published.	Year.	Published.
1869 - - -	1871	1875 - - -	1879
1870 - - -	1872	1876 - - -	1884
1871 - - -	1874	1877 - - -	1885
1872 - - -	1873	1878 - - -	1887
1873 - - -	1875	1879 - - -	1889
1874 - - -	1877	1880* - - -	—

* In progress, Parts III. and IV. still to appear.

In place of this publication there have been successively issued, first, the Monthly Weather Report, and subsequently, the Monthly Summary of the Weekly Weather Report.

Other Periodical Reports.

Monthly Weather Report, 1884–1887 (January to August), published; 1881–1883 and 1887 (September to December), still to appear.

This publication ceases with the year 1887, and the information it supplied is now given in the Monthly Summary of the Weekly Weather Report.

The Weekly Weather Report, which is prepared in the Telegraphic Branch of the Office (see Appendix VIII., p. 88), has been considerably modified in form, with a large saving of expense, and now supplies, by its synchronous charts, a very complete and instructive view of the chief meteorological changes, day by day, over the greater part of Europe, such as is not to be found in any of the similar publications issued by any other office.

Publications.

A Monthly Summary, replacing the former Monthly Weather Report, appears as a supplement to the Weekly Weather Report.

Appendix I. to the Weekly Weather Report for 1889 gives a summary for each quarter, and for the whole year, of the Rainfall and Temperature for each district, for the 24 years 1866–1889, and also the Monthly and Progressive values of Accumulated Heat, Rainfall, and Bright Sunshine for all the districts in each month of 1889. Appendix II. to the same Report gives the Weekly and Progressive values for the same elements during the year 1889 (in continuation of Appendix II. for the year 1888), and Appendix III. gives the Mean Weekly values for the following number of years:—

Accumulated Heat and Rainfall, 11 years, 1878 to 1889.
Bright Sunshine - - 8 „ 1881 „ 1889.

Appendix IV. gives for each district, for the 12 years 1878 to 1889, the mean temperature for each week in the year.

Hourly Readings.—After full consideration the Council have resolved to make a very considerable alteration in the form of publication of the *Hourly Readings* obtained from the records of the self-registering instruments at the four principal observatories, and to commence the new series with the year 1887. The calculations for that year are in an advanced stage, and will shortly be ready for press. In future the publication will consist of a carefully arranged series of mean values, which it is believed will prove more generally useful than the publication of the hourly readings *in extenso*, which has hitherto taken place. The new series will comprise—

(1.) *Hourly* means of pressure, temperature, the difference between the dry and wet bulbs, and of wind components, together with the amount and frequency of rain; these hourly means will be for periods of (*a*) five days, (*b*) calendar months, and (*c*) the year.

From these will be computed the harmonic components of the hourly and yearly mean variations of pressure and temperature for each month and for the year.

(2) The daily, five-daily, monthly, and yearly means of pressure and temperature.

(3.) The monthly and annual falls of rain will be given as heretofore.

(4.) The wind results will be given in the form of mean components, referred to the four cardinal points, the Council considering this to afford upon the whole the best solution, although by no means an altogether satisfactory one, of the difficult problem of dealing with the mean direction of the wind.

The computation of mean hourly values of the temperature of the air and of barometrical pressure for the seven observatories and for each month of the year 1883 has been completed, and the Council has decided to extend the work to all those years preceding 1883 for which data exist and which have not already

been dealt with, and considerable progress has been made with the work. Publications.

Observations at Stations of the Second Order.—The volume for 1885 has appeared, and that for 1886 is in an advanced state.

The number of stations, 32, from which the returns have been of late years published *in extenso* has been considerably in excess of the number, 15, proposed by the Congress of Rome in 1879, and the Council has therefore resolved to reduce the present number to 21, which they consider to be sufficient, while it will considerably diminish the cost of the publication. At the same time the number of stations from which monthly means and summaries only are published in a concise form, has been increased from 14 to 45.

The following is the list of stations for which returns will be published for 1886 and future years:—

STATIONS for PUBLICATION in DETAIL on Form A., 21 in Number.

Stations.	In connexion with	Years already published in detail.	Remarks.
Glasgow - -	M. O.	10	Formerly observatories. 10 years hourly readings already published.
Stonyhurst -	M. O.	12	Continuous records of pressure, temperature, wind, and rainfall still available, except for Armagh, which furnishes wind and rain only. For Stonyhurst and Armagh the records for 1884 and 1885 have been published among the stations on Form A.
Armagh - -	M. O.	12	
Dunrobin Castle -	S. Met. Soc.	6	
Braemar - -	S. Met. Soc.	6	High-level station (1,113 feet).
Dundee - -	S. Met. Soc.	6	
Wolfelee - -	S. Met. Soc.	—	
Scarborough -	R. Met. Soc.	5	
Hillington -	R. Met. Soc.	9	
Churchstoke -	R. Met. Soc.	10	Sutton Coldfield to be substituted for Churchstoke for 1889.
Carmarthen -	R. Met. Soc.	11	
Margate - -	R. Met. Soc.	4	
Dartmoor (Princetown).	R. Met. Soc.	7	High-level station, 1,395 feet. The only high-level station available in the south of England.
Swanbister -	M. O.	—	This is the most northern station available, and there is a continuous record of wind.
Laudale - -	M. O.	7	
Douglas (Isle of Man).	M. O.	8	
Southampton -	M. O.	8	At both of these stations there are long series of observations available taken by the officers of the Ordnance Survey.
Dublin (Mountjoy Observatory).	M. O.	—	
Markree Castle -	M. O.	11	
Parsonstown -	M. O.	13	
Londonderry -	M. O.	7	

LIST for PUBLICATION on Form B. (Monthly Means and Summaries).

Swanbister.
Lairg.
Dunrobin Castle.
Gordon Castle.
Glencarron.
Aberdeen.
Fort Augustus.
Braemar.
Fort William.
Lednathie.
Laudale (Argyleshire).
Dundee.
Ochtertyre.
Callton Mor.
Glasgow.
Rosewell.
Rothesay (Isle of Bute).
Marchmont.
Wolfelee.
Pinmore (Ayrshire).
Glenlee.
Cramlington.
Cargen.
Scaleby (near Carlisle).
Durham.
Newton Reigny.
Aysgarth (Yorkshire).
Scarborough.
Cronkbourne (Douglas), Isle of Man.
York.
Stonyhurst.
Wakefield.
Prestwich.
Llandudno.
Buxton.
Cheadle.
Hillington (Norfolk).
Leicester.
Uppingham.
Churchstoke (Montgomeryshire).
Geldeston (Beccles).
Bennington.
Cheltenham.
St. David's.
Carmarthen.
Berkhamsted.
Kew.
Margate.
Southampton (Ordnance Survey Office).
St. Leonard's.
Southbourne.
Rousdon.
Dartmoor.
Babbacombe (Torquay).
Falmouth.
Londonderry.
Lissan (Co. Tyrone).
Armagh.
Brookeborough (Colebrooke Park).
Markree Castle (Sligo).
Dublin (Glasnevin).
Dublin (Mountjoy Observatory, Phœnix Park).
Dublin (City).
Parsonstown (Birr Castle).
Killarney.
Valencia.

The Stations marked S belong to the Scottish, and those marked R to the Royal Meteorological Society.

Observations on Ben Nevis.

Observations on Ben Nevis.—The arrangements made with the Directors of the Observatory on the summit of Ben Nevis, at a height of 4,406 feet above the sea, and explained in the Report for 1885, remain in force, and the Council have continued the annual grant of 100*l.* towards the expenses of the Observatory, and have received MS. copies of all the meteorological observations taken.

The building of the new observatory at Fort William is now completed. It was explained in the last Report that the Council had agreed to subsidize this observatory to the extent of 250*l.* a year, and supply it with the necessary outfit of instruments. These will shortly be sent down and erected.

Sea Surface Temperature.

Sea Surface Temperature on the Coasts of the British Isles.—These observations, which are obtained through the courteous assistance of the Admiral Superintendent of Naval Reserves, the Trinity House, and the Commissioners of Irish Lights, are still continued, and a large amount of valuable information is thereby collected.

Cloud Photography.

Cloud Photography and Measurement.—This subject has continued to receive attention, but as yet satisfactory results have not been obtained.

The Bridled Anemometer.—The experiments with the bridled anemometer, an instrument intended to record strong gusts of wind, which have been undertaken by Mr. W. H. Dines, as intimated in the last Report, have been continued, and the result has been to show that the cups, placed in the same plane, at the ends of short arms, exercised appreciable interference on each other. The anemometer will be altered to remedy this defect. Further experiments have also been carried on by Mr. Dines at Hersham with respect to other questions relating to wind. An account of these will be found at Note B., p. 36. The Bridled Anemometer.

Electrical Anemometer.—This instrument has now been erected at Kew for the purpose of ascertaining whether its indications can be utilized. The results hitherto have not been satisfactory. Electrical Anemometer.

Violle's Actinometers.—At the request of the Solar Physics Committee the Council have undertaken to institute some experiments at Kew Observatory on Violle's apparatus for measuring solar radiation. (Note C., p. 46.) Violle's Actinometer.

The Harmonic Analyser.—The analysis by this instrument of the barograms from the seven observatories has now been completed for the 12 years 1871–1882 inclusive. The corresponding results obtained from the thermograms were published in 1886. The Harmonic Analyser.

In consequence of the resolution of the Council to undertake the calculation of the mean hourly values of pressure and temperature, the question arose whether the harmonic constants might not be obtained in a more complete and satisfactory manner by arithmetical computation than by the mechanical process. The Council therefore thought it advisable to ascertain as far as possible what was the degree of accuracy obtainable by the use of the machine, and what were the causes of error likely to arise.

For this purpose a series of experiments has been carried out, more complete than those before made, the result of which has been to show that, owing to certain difficulties which are experienced in passing the curves through the machine, and which could not be avoided without making a very considerable alteration in the mechanical details of one portion of the instrument, the results obtained by a mechanical analysis of the curves are liable to errors which, though small in themselves, are important in relation to the quantities being dealt with, which are themselves very small.

From this and other considerations, and from the character and results of the experiments upon the operation of the machine which will be found in fuller detail in Note D., p. 47, the Council have resolved to obtain the harmonic coefficients by arithmetical computation in preference to the use of the machine, though the machine may for certain purposes be found very useful.

Thermometers for Cotton Cloth Factories.—The Cotton Cloth Factories Act, 1880, states that in every such factory there shall be provided, maintained, and kept in correct working order two sets of "standardised" wet and dry-bulb thermometers. In the Thermometers for Cotton Cloth Factories.

Thermometers for Cotton Cloth Factories.

month of January the Council were requested by the Home Office to inform the Secretary of State how thermometers had best be "standardised" for the purposes of the Act. The Council replied that thermometers were at present being verified at the Kew Observatory of the Royal Society to the extent of several thousands annually, and that accordingly the testing of such instruments presented no difficulty.

Records from stations of the Royal Engineer and Army Medical Departments.

Observations from Military Stations.—The summaries of these observations, made under the direction of the Royal Engineer and Army Medical Departments, between 1852 and 1886, have been completed, and the volume has now been issued.

Trevandrum Observations.

Trevandrum Observations.—On the death of Mr. J. Allan Broun, F.R.S., in 1879, the desirability of discussing and publishing the records of the observatory at Trevandrum, in Southern India, which had been carried on under his superintendence for over twelve years, was brought before the Royal Society of London by the Royal Society of Edinburgh. The whole of the records, 31 volumes, were subsequently (in 1880) deposited at the Meteorological Office, by Mrs. Broun, for safe keeping. The negotiations on the subject with the Indian Meteorological Department at that time led to no result. The Meteorological Council have now resolved to make another effort to induce the Indian Authorities to render the very valuable material contained in these MSS. accessible to scientific men, and have addressed the Royal Society on the subject.

Library.

Library.

The library contains standard works on Meteorology and the allied Sciences, and is, besides, particularly rich in Transactions, Proceedings, Reports, and other Publications which give a large mass of Meteorological observational data from all parts of the world, extending over many years. It consists at present of over 11,000 volumes and pamphlets, exclusive of charts and MS. records of observations. The books and other documents are accessible to scientific men for reference at the Office.

Appendix XVIII., p. 113, contains a list of the additions to the library during the year, which have been catalogued upon cards, and are entered in the reference catalogues under (1) Authors, and (2) Subjects.

Expenditure.

Financial.

Appendix XIX., p. 138, shows the receipts and payments during the year ending 31st March 1890. The amount voted by Parliament was 15,300*l.*, as in the previous year.

The following abstract of expenditure shows the amount properly chargeable to the year in question, and its distribution under the

various heads, together with the increase or decrease in 1889–90, as compared with the previous year :—

Net Expenditure.	1888–89.	1889–90.	Increase.	Decrease.
General Administration:	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Payment of Council -	1,000 0 0	955 18 4	—	44 1 8
Secretary - -	800 0 0	800 0 0	—	—
Office - - -	798 8 0	801 4 2	2 16 2	—
Rent, fuel, and lighting -	709 17 11	701 14 3	—	8 3 8
Alterations to premises, attendance, and contingencies - -	436 4 0	474 7 6	38 3 6	—
Expenses incidental to International Meteorological Congress -	22 2 3	5 2 0	—	17 0 3
Pensions - -	138 16 4	186 16 4	48 0 0	—
Special Researches -	570 5 0	710 10 6	140 5 6	—
Land Meteorology -	3,353 7 1	3,544 9 11	191 2 10	—
Weather Information -	3,845 10 4	3,777 19 5	—	67 10 11
Inspections - - -	702 5 1	664 2 5	—	38 2 8
Ocean Meteorology -	2,795 3 3	2,736 9 4	—	58 13 11
Total - - £	15,171 19 3	15,358 14 2	420 8 0	233 11 3

In the year 1889–90 the sum of 1,606*l.* 9*s.* 5*d.* was paid to the Post Office on account of inland and foreign telegrams, allowances to clerks, and rental of private wires.

(Signed) R. STRACHEY,
Chairman.

NOTE A.

CODE of REGULATIONS, &c., &c., for conducting the WORK at the FIRST-CLASS OBSERVATORIES, and the EXAMINATION thereof.—1889.

THE errors to which the traces derived from self-recording meteorological instruments, and the numerical values obtained from them, are subject, are of three classes, viz. :—

i. Errors in the traces themselves, including those due to faulty attachment of the paper upon which the curves are produced.
ii. Errors of date and time-scale entered upon the papers.
iii. Errors in tabulating from the traces.

Errors in the Traces themselves.

With a view of avoiding, as much as possible, errors included in the first category, the attention of observers in charge of instruments is directed to the following points :—

Care must be taken that the gas flames in the instruments are so adjusted, and the condensers and reflectors so fixed, that the barometer tube and two thermometer tubes with their attached shields are at all times well illuminated.

In the event of a very exceptional rise or fall of pressure or temperature, and when the observer has reason to fear that readings will otherwise be lost, the instrument should be temporarily raised or lowered by means of the screw, so that the record of extreme values may be secured.

But as any alteration of the positions of the instruments, especially of the barometer, throws out the zero of the scales, this measure should only be adopted with extreme caution.

In all cases when changes in the positions of the instruments are made, careful eye observations should be made before and after each change, to guard the records from the effects of erroneous index errors, or errors of zero lines.

In the case of the barometer the instrument should be carefully restored to its original position as soon as the occasion for the change has passed away.

The thermometers, however, must be regularly raised and lowered by the screw suspending them, in the course of every year, in order to secure sufficient illumination for the portion of the scale likely to be in use in summer and winter respectively: and care must be taken not to postpone this operation in spring and autumn until some of the readings have been lost.

Great care should be taken that all the parts of the instruments are working correctly, and are free from dust.

Before wrapping the photographic paper round the cylinders it should be carefully examined as to the freedom from blemishes or defective coating of the sensitive surface, and when fixed in its

place on the cylinder a second examination should be made to see that while it is everywhere in close contact with the cylinder, there is no bagging or bulging, and that its edge is parallel to the edge of the cylinder nearest to the trace. Care should also be taken in cutting off the superfluous paper, that no loose ends are left projecting, as they are liable to cause a stoppage of the clock.

The prepared papers for use with the anemograph and rain-gauge require similar precautions to be taken with regard to wrapping them upon the cylinders; but additional care is also required, so that the lines ruled upon these papers are made to coincide with certain points of the apparatus designed for the purpose of properly setting the instruments.

After placing a new sheet of prepared paper on the cylinder of the rain-gauge, the glass tabulating scale should be used to see that the printed scale on the paper is parallel with the edge of the cylinder. The height of the pencil is next adjusted so that, the bottle being empty, the trace runs along the zero line of the blank paper, when the cylinder is turned by hand.

The float is also to be depressed by the finger and allowed to rise again in order to see that it is free to act throughout its whole range.

Great care should be exercised to avoid interfering with the instruments or their positions, but when any alteration of position, or interference with, or interruption of, their action occurs, an explanatory note of the causes of all deficiences should be made on the curves and tabulations.

Errors of Time and Date.

Observers should set their watches daily to correct G.M.T., either by reference to a standard clock, or to a chronometer corrected to the true time for the day by means of a table of going rates. The instrumental clocks should all be set to this correct time at the time of changing the papers, and comparisons should be made at every observation hour in order to see that no stoppage has occurred in the interval which has elapsed between the observations.

In the case of the photographic instruments, after changing the papers, the observer should, if possible, listen for the sounds produced by the closing and opening of the light shutter, which will show that it is duly performing its duty.

The error of the instrument clocks should never be allowed to exceed two minutes in the two days.

The instrumental clocks should all be wound daily between the hours of 10 and 11 a.m., fresh papers being placed daily on the cylinders of the anemograph and rain-gauge, and on alternate days on the barograph and thermograph. The observer should carefully note the exact time at which the clocks are stopped or the cylinders detached from the driving gear, and should also read the indications of the dials and time-scales, noting them down at

the time on the journals, and on the reverse sides of the anemograph sheets. Similar memoranda should also be jotted down of the time at which the instruments are again set in action. The photographic sheets to be marked with the initials B_1, B_2, and T_1, T_2, in addition to the date, as a guide to the photographer in his operations, the sheets marked B_1 T_1 being the outer.

As soon afterwards as time permits, the dates should be permanently and distinctly written up in ink, the time-scales, &c. stencilled on, and the clock times and check standard readings entered on the sheet in accordance with the regulation pattern.

The wet bulb thermogram should be examined for places where the damping was inefficiently performed, and remarks made accordingly.

Check observations of the standard thermometers and barometer should be made five times daily; those of the thermometers at the moment coincident with the shutting off the light from the curve at two minutes before the even hour, and those of the barometer when the light is restored at two minutes after the even hour.

General Instructions.

WET-BULBS:—At the times of reading the standard thermometers the state of the wet-bulbs of both the standard and self-recording instruments ought to receive attention. If both bulbs seem to be properly wetted, and sufficient water is in the cistern to maintain them in the same condition until the next visit of the observer, the sign ✓ should follow the entry of the standard reading in the observation book and journal. If either of the bulbs is wholly or partially dry at the time of observation, a note should be made to call the attention of the tabulator to the unsatisfactory nature of the observation at that hour, and the observer should proceed to damp the thermometer at once.

In time of frost the bulbs should be kept covered, if possible, with a thin coating of ice by applying, at frequent intervals, a little cold water directly to the surface of the bulb. When the air is too moist to allow of this ice jacket evaporating or the temperature is at or about the freezing point, and the ice does not melt off the bulb quickly enough, it should be melted off by using a little warm water. This may also serve to thaw the ice in the supply tank, tubes, and threads, which might otherwise fail to act properly.

In hot and dry weather it is sometimes found that difficulty occurs in maintaining the wet-bulbs in a properly moistened condition. In such cases the tank should be refilled at more frequent intervals than usual, and also new threads and muslin should be fitted up. It is necessary to soak well, or boil in water, the threads and muslin before they are used, in order to remove from them any gum or starch, the presence of which seriously reduces the capillary actions.

The water supplied to the wet-bulb cistern should, if possible, be rain water, and always be taken from a vessel exposed to the

air, so that its temperature may be that of the air, this being of importance. The best plan is to save and use the water collected from the rain-gauge as being free from lime, which in the case of hard water forms an incrustation on the muslin; when this is observed the muslin should be changed.

Flooding from excess of water often occurs when the cistern is refilled, vitiating the record for a quarter of an hour or more after replenishing.

The water cistern should, as a rule, be filled after reading the thermometers; and it is advisable to restrain the flow of water so that no more runs over the bulb than is requisite to keep it completely moistened. The lowest points of the thread should always be somewhat lower than the *points of attachment* of the thread to the thermometer bulb, so that the water rises to the bulb by capillary attraction. Notes of the times of adding water must be made on the curves.

ANEMOGRAPH:—Once a month, on a calm day, the orientation of the anemograph should be tested in order to see that the direction of the wind is being properly recorded, and that no slipping has taken place in any of the joints of the shafting. Opportunity should also be taken of this, to oil the instrument thoroughly, and to see that the bearings are free from dirt.

Full details as to how this is to be performed are given in a special circular of instruction which was issued in March, 1882.

RAIN GAUGE:—As regards the rain-gauge, particular care must be taken to change the recording papers every day at about the hour of 10 a.m.; the observer must never assume absence of rain in the 24 hours, as a shower may fall unnoticed during the night.

At the time of changing the rain-gauge papers the observer should always empty the contents of the receiver into the measuring glass, and compare the amount so measured with that indicated at the time by the curve, recording on the sheet the sum of the discharges *plus* the quantity so measured.

The measurement of snow by this gauge does not give very satisfactory results. Probably the best method is to collect the snow contained in the receiver into a vessel, and having melted it, to pour the water through the gauge in order to show the trace. In such cases the measurement of the hourly values should not be attempted, but the total amount entered at the latest hour to which the trace extends.

A spare gauge of the 8-inch pattern should be kept in the close vicinity of the Beckley gauge, and its contents measured immediately after the latter has been seen to.

Any material discrepancy between the indications of the two instruments should be noted in the weather journal, and endeavours made to ascertain its cause.

SUNSHINE RECORDER:—The cards are to be changed if possible at sunset each day, or if this is inconvenient, at some

other fixed hour, which having been chosen, is to be adhered to as closely as possible.

The card is to be changed even if it has not been scored, and the identical card which was in the instrument returned to the Meteorological Office.

If the weather be windy it is advisable to insert a small wedge of paper so as to hold the card firmly in its groove.

In time of snow, when there is any chance of sunshine, the snow should be removed from the ball and from between the ball and the card. Hoar frost should also be removed from the ball as soon as possible, and the ball should occasionally be wiped to remove any dirt which may have become deposited upon it.

Every card should have clearly written upon it the name of the observatory, the date, and the time of insertion and withdrawal, using local apparent time; this is especially important if the cards are changed while the sun is shining. Should the instrument have been moved, or should anything have occurred to interfere with the accuracy of the score in any way, an explanatory note should always be written on the back of the card.

The cards are to be returned to the office as soon as possible after the close of each month. In packing them for transmission through the post they should always be kept flat and never be folded.

Further particulars as to the setting of the instrument, obtaining local apparent time, &c. will be found in a special circular issued January 1889, entitled "Directions for adjusting and using the Sunshine Recorder."

Tabulation of traces and discovery of Errors.

Tabulation forms are provided for the entry of the measurements made from the automatic traces. These have to be suitably prepared for use by having written upon each of them on every page the name of the observatory and a consecutive number corresponding with that given in the diary issued by the Meteorological Office for each year. The dates are next entered, care being taken that they accord with the entries in the diary and journals, and also that each month's work is kept totally distinct from any other. New forms throughout should be brought into use on the first day of every month.

Barograms.—The curve being duly written up and dated, is fixed in the tabulator frame and the scale fitted, the brass time-scale being adjusted so that the measuring bar-catch accords with the time gaps on the barograph curve indicating the even hours, in order that the reading glasses may be properly placed for the *odd* hours, not so indicated.

The reading glasses—the upper being set so that when the zero of the scale corresponds exactly to 30·0 ins. the distance between the cross lines on the two glasses shall agree with the scale value supplied by the Meteorological Office—are then moved until they stand tangential to the curve at both the upper

and the lower margins, and the corresponding barometric pressure is then read off, and entered in the line and column of the tabulation form for the corresponding hour and day. This is done for every hour of the week's series of curves, and in accordance with the notes on the tabulation.

The absolute highest and lowest points shown on the curve for each day should also be noted and recorded.

A second series of tabulations of a less degree of refinement (to be employed as a check) follows, the readings being made by means of an ivory scale, read to the nearest hundredth of an inch only, and the readings entered in a second blank form known as a Subsidiary Sheet. If possible the two sets of measurements should be taken by different persons.

The entries in the first form, in hundredths only, are then copied into the subsidiary sheet beside the other set. The differences are next taken, and when they exceed ·01 inch from the normal, a re-examination of the corresponding point on the curve is made, the faulty reading crossed through (not erased or altered), and the corrected value entered above it.

Should any portion of the curves be too faint for measurement with the ordinary tabulating instrument, but not for the ivory scale, it ought to be so measured, such measurements to be indicated in the tabulations by the addition of the word "approximate." On no account should the curves be pencilled or inked in.

The barogram readings should next be compared with the check observations of the standard barometer.

The readings of the standard having been corrected for index error and for capillarity, and reduced to 32°, should be entered in the "S" column of the tabulation form *prior to the tabulation of the curve.* The values of the barograms, corresponding to the times at which the standards were read, should be measured and entered. The differences between each pair of these observations should then be taken for the period from 11 a.m. of one day to 11 a.m. of the next, and from the mean of all of these which do not vary as much as 0·008 in. from the average of the whole, a mean difference or "residual correction" for the period under discussion is formed. Should less than three standards be available, if it is not the day on which the curves are changed, the *residual* is calculated for the whole curve, but if it be changing day, it is calculated up to midnight of the following day. In extreme cases great range of pressure might modify this rule.

If the resulting mean difference be less than 0·001 in. it is considered that there is no residual correction, and the hourly values should be entered direct into the column headed "Tabulated value corrected." If a residual be formed they should be entered in the "H" column.

The residual correction is applied to all the tabulated values of the barogram, and the corrected values compared with the corresponding standard barometer readings. Where a difference exceeding 0·007. in occurs, an examination of the accuracy of the

curve measurements is made, and if this is found correct, the standard reading is concluded to be erroneous, and is marked on the tabulation sheet by means of brackets as (30·050). If necessary, on account of this rejection, a second residual correction is computed, applied to the original readings, and comparison with standards made anew.

Thermograms.—The thermograms are virtually registers of two separate instruments on one sheet of paper, and are, in the question of tabulation, treated as perfectly independent traces; dry-bulb and wet-bulb thermometer readings.

A thermogram is laid on a flat table, and covered by a glass scale engraved with two sets of parallel lines crossing one another at right angles, arranged to represent degrees of temperature and hours of time; the zero line of the curve is then made to lie along a previously determined line of the degree scale of the glass, whilst the lines crossing are made to correspond with the left-hand margin of the gaps in the curve indicating time.

The observer then having set his scale, and noticed that the indications of stopping and starting the curve are in accordance with the times indicated by the graduations on the glass, proceeds to read the position of the upper margin of the photographic sinuous line as referred to the degree lines every hour, and enter the readings on the corresponding tabulation form. This done for the whole week, the curves are again taken, and re-measured at each hour with an ivory scale, graduated to correspond with the glass scale. The readings of this scale are entered in a subsidiary sheet, as in the case of the barograms, and are compared with the corresponding readings already made by the glass scale, copied from the original tabulation into this sheet. When the difference between the two sets of measurements amounts to 0°·3, the curve is again read off at the point in question, the faulty reading struck through, and the correct one entered above it.

Next, the check observations of the standards, duly corrected for index error, are copied from the journals, and entered into the proper columns in the tabulations.

These are compared with the tabulated values, and if differences exceeding 0°·5 are found, those readings are examined, and, if necessary, the eye observations are struck out by being bracketed.

Finally, the points of maximum and minimum temperature each day are selected on the curves, and their values and times of occurrence noted and recorded.

A similar method of tabulation is pursued with regard to the trace of the wet-bulb thermometer, but with the difference that the observer has to carefully guard against entry of observations for those hours when the curve is marked, indicating that the instrument has been acting improperly.

In the case of the wet-bulb instrument, maxima and minima are not recorded.

Faint curves are to be treated as prescribed for the barograms.

Anemograph.—In this apparatus both velocity and direction of the wind are recorded mechanically on the same sheet of paper.

As the clock moving the recording cylinder is not provided with an automatic time-marker, the only guides as to correct timing of the traces are the positions of the two ends of the curves on the printed sheet, the observer should note that these correspond with the two small pin-holes made by a pricker attached to the instrument, which is depressed momentarily at the times of putting on and taking the sheet off the cylinder. If these do not accord within 10 minutes, with the times indicated by the ends of the traces, a fresh time scale must be ruled to agree with them, and the curves tabulated from the new scale.

The hourly wind velocity is measured with a glass scale, which gives the run of the Robinson cups from 30 minutes before to 30 minutes after each hour.

These values are entered in the tabulation sheet, and a correction for friction theoretically computed by Dr. Robinson applied to all velocities below 11 miles as follows:—

0 m.	- corr.	=	1·5 miles.
1 m. to 3 m.	„	=	1·0 „
4 m. to 10 m.	„	=	0·5 „

No subsidiary measurement is made for each hourly result, it being considered sufficient if the aggregate of the 24 uncorrected hourly velocities agrees within 5 miles with the whole distance run by the wind on the curve.

The wind's direction for every hour is deduced from the position of the centre of the trace, which constantly varies in width owing to the oscillations of the wind. For this purpose another scale is used, engraved to accord with the scale printed upon the paper; should this slightly differ from that determined for each instrument by the operation of orientation performed monthly, due allowance must be made in setting the scale.

The subsidiary measurements in direction are made by inspection of the anemograms and entering on a form the special position of the traces marked thereon for each hour. The results are entered on a special form and compared with the readings obtained by the glass scale.

An examination should be made in all cases where there is a difference of two points between the two readings.

Beckley Rain-Gauge.—This registers the time of fall of rain and the amount deposited in a funnel of 100 square inches area, placed 21 inches above the surface of the ground.

The rain from the funnel runs into a copper bottle floating on mercury, and, by its weight, depresses it. A pencil attached to the bottle is drawn by its descent down the paper wrapped round the drum.

When 20 cubic inches of water, corresponding to a rainfall of two-tenths of an inch, have been collected, a siphon causes the

bottle to discharge, and the float rises to its first position again, carrying the pencil up to the zero of the curve ready to make another trace.

The pencil should be adjusted to press on the paper with such force that it may have sufficient power to make a good trace, but not such as to prevent its rising to the top of the form on the paper, after a discharge assisted by a Stonyhurst lifter.

Measurements of the rain which has fallen during every hour are made from the curves by means of a glass scale. The hourly quantities should be entered in the tabulation form opposite the hour which indicates the end of the period to which the measurement refers, and the sum of the readings for the 24 hours should agree with the quantity gauged at the time of changing of the papers.

General.—The documents and curves should be forwarded to the Meteorological Office every Thursday as directed by the "Diary of Operations."

Regulations as to the Examination of the Tabulations at the Meteorological Office.

Assistant's Instructions.

General.

(1.) Examine each curve in order to see if there is any want of light, bagging, finger-marks, or bad photography.

(2.) See that the clock and shutter have been in good action throughout the curve.

(3.) That the instrumental clock does not differ more than two minutes from the chronometer time as recorded on the curve.

(4.) That the date written on the back of the sheet agrees with that on the face, and that the days of the week and month at the top of the curve are correct.

(5.) That the sheet is properly written upon after the pattern.

(6.) That in the journals the proper day of the month is placed alongside of Sunday, and that the others follow consecutively.

(7.) That the times of starting and stopping the instrument as recorded on the journal have been properly entered on the curve.

(8.) Finally, ascertain, by inspection of the curve, that its times of beginning and ending are the same as those inscribed on the face of the sheet, and that no slipping of the cylinder has taken place.

Barograms.

(9.) See that the journal readings of the standard barometer have been correctly reduced to 32°, and are entered under their proper dates into the barograph tabulation sheets, differences of ·003 in. and upwards being noted as errors of reduction.

(10.) Compute the differences (S—T), (with their proper signs), between the standard reading (S) and the corresponding corrected hourly value of the barograph (T). In all cases of differences exceeding ·007 in. the hourly value should be checked, and if, on repetition, found to be correct, the standard reading should be rejected as probably faulty. The mean monthly differences should be recorded.

(11.) See that the tabulated hourly values have been correctly copied into column "A" of subsidiary sheets, and check the accuracy of the subtractions made in the tables occasionally.

(12.) Investigate all cases where A—B is ·02 in. greater than the normal difference; if an error be revealed in the tabulations, it ought to be corrected and noted at once.

(13.) By means of the ivory scale examine all cases where the differences between two consecutive hourly values amount to or exceed ·05 in. The values are to be corrected for errors of ·01 in. and upwards, a note thereof being made on the "Notes of Errors" Sheet. These corrections ought to be made before the next step in the process is commenced.

(14.) Ascertain the correctness of the computed residual correction, and whenever it is necessary to alter it, the last column of the tabulations should be corrected to correspond.

(15.) Check the accuracy with which the residual corrections have been applied, and correct any errors.

(16.) Make 40 re-measurements in every month's work for each observatory, selecting those parts of the curves most favourable for accurate measurements.

Thermograms.

(17.) See that the journal readings of the standard thermometers are entered under their proper dates into the thermograph tabulation sheets; and that they have been properly corrected for index error.

(18.) See that the tabulated hourly values have been correctly copied into column "A" of subsidiary sheets, and check the accuracy of the subtractions made in the tables occasionally.

(19.) Investigate all cases in which A—B is 0°·5 Fah. or more above the normal difference, and correct any errors.

(20.) Compute the differences (S—T), (with their proper signs), between the standard reading (S) and the corresponding hourly value of the thermogram (T).

(21.) In all cases of differences between "S" and "T" exceeding 0°·5, the hourly value should be checked, and if, on repetition, it be found to be correct, the standard reading should be rejected. The monthly mean differences between the simultaneous standard and thermograph readings should be recorded.

(22.) By means of the ivory scale, examine all cases where the difference between two consecutive hourly values amounts to, or exceeds, 5°·0. The values are to be corrected for errors

of 0°·3, and when they amount to 0°·5 a note thereof is to be sent to the observatory.

(23.) Compare the dry-bulb readings with the corresponding wet ones, marking and examining all those cases in which the latter appear higher than the former.

(24.) Check the accuracy of the times and values of the maximum and minimum temperatures.

(25.) Make 40 re-measurements in every month's tabulations of both the dry and wet bulb traces for each observatory, selecting parts most favourable for accurate measurement.

(26.) Measurements for the purpose of checking the values of the zero lines are to be taken when the mean monthly difference amounts to ±0°·25, the said difference not being caused by errors in measurement, or reading of the standards.

Anemograms.

(27.) Examine each curve in order to see that both pencils work well and freely, that the paper has been accurately attached to the cylinder, and the cylinder has not slipped.

(28.) See that the times of starting and stopping the instrument as recorded by the pricker and traces, do not differ more than five minutes from the chronometer time, inscribed on the sheet.

(29.) Inspect the direction and velocity wind curves in connexion with the tabulated results, in order to ascertain that each curve is tabulated under its proper date.

(30.) Examine all cases in which A—B is *two points* and upwards, and correct when necessary.

(31.) Examine all differences between two consecutive hourly values of velocity amounting to 10 miles.

(32.) Make 40 re-measurements in every month's work for each observatory, both for direction and velocity.

Rain Curves.

(33.) See that the clock has been in proper action; that the pencil has worked well and freely; that the paper has been properly attached to the cylinder; and that the cylinder has not slipped.

(34.) That the curve is properly written upon, and that the times of putting on and taking off, as shown by the trace, do not differ more than five minutes from the recorded times.

(35.) See that the total rainfall entered upon the curves agrees with that shown by the trace, and also with the record of the spare gauge.

(36.) That the trace had been tabulated from hour to hour, and make a general examination of the hourly values.

(37.) See that in tabulating, a proper allowance has been made for retardation of the pencil (through friction), bad attachment, bagging, &c.

GENERAL NOTE.

Whenever any error of time amounting to 10 minutes (and which has not been allowed for in tabulating) is discovered in a curve, re-tabulation will be necessary.

Curves erroneously tabulated should be returned to the observatories for re-tabulation.

Meteorological Office (*Secretary*).

The assistant shall report upon all curves and tabulations that are deficient from any cause, and the Secretary shall make the necessary communications to the Meteorological Council on the one hand, and to the director of the observatory where the failure occurred on the other, with any remarks that may tend in his estimation to obviate in future the causes of failure.

The Secretary shall also cause a tabulated report of the results of the examination of each month's work to be made to the Meteorological Council, and a copy of the "Notes of Errors" to be forwarded to each observatory concerned.

The foregoing regulations apply to the examination of the traces of self-recording instruments, and the tabulation of the numerical values intended for final record and publication. But a general inspection of all the traces should be made immediately on their receipt, so that any defects apparent, on such an examination as can be made without instrumental appliances, may at once be brought to notice.

NOTE B.

Note on Experiments on Pressure of Wind made by Mr. W. H. Dines.

Mr. Dines first took up this subject at the instance of the Wind Force Committee of the Royal Meteorological Society, and his experiments were directed to a re-determination of the factor of the Robinson cup-anemometer, the exact value of which was still involved in some doubt.

The experiments were made with a whirling machine of 29 ft. radius, driven by steam, erected in a level and somewhat sheltered field at Hersham, Walton-on-Thames. The results of the experiments were published in the Quarterly Journal of the Society, Vol. XIV., p. 253, and Vol. XVI., p. 26. Mr. Dines found the factor to be about 2·2, and thus practically confirmed the conclusion of Sir G. G. Stokes, who deduced (Proc. Roy. Soc. 1881, p. 170) the value 2·3, in place of 3 as found by Dr. Robinson.

As Mr. Dines had shown great skill in devising and carrying out these experiments, and had expressed his willingness to continue his researches with his whirling machine, the Council considered it desirable that the opportunity thus presented should be utilised for further experiments in certain branches of aërodynamics.

A grant was accordingly made, and Mr. Dines proceeded to investigate the connexion between the velocity of the wind and the pressure on obstacles of various kinds. A full description of the experiments and of the results was submitted to the Council in May 1889, and has since been published in the Quarterly Journal of the Royal Meteorological Society, Vol. XV., p. 1; it will therefore here suffice to give a summary.

The natural wind is not available for experiments on wind pressure, because it is usually gusty and variable in direction, and because it is not easy to measure its velocity with accuracy. It thus becomes practically necessary to have recourse to a whirling machine. But if such a machine be made on so small a scale that it can be sheltered from the natural wind, then, unless the pressure plate be small, the circularity of the motion introduces a large error, and besides the possibility of the persistence of eddies in the air may be a cause of uncertainty in the results. A whirling machine should be therefore on a large scale and must accordingly be erected in the open air. Under these conditions, the natural wind, which always exists to a greater or less extent, is superposed on the artificial wind, and the total wind, to which the pressure is due, oscillates about a mean value in the course of each revolution of the whirler.

These various difficulties have, however, been obviated by Mr. Dines by means of an ingenious device.

It has long been known that, to a close degree of approximation, wind pressure varies as the square of the velocity of the wind. Now if a weight be swung round in a circle the restraint required to keep it in its course varies as the square of its velocity. It therefore occurred to him to balance the pressure on the experimental plate, when carried round by the arm of the whirler, by the centrifugal force, or tendency to fly outwards, of a weight swung round by the same arm. This plan was found to answer admirably, for when the right amount of centrifugal force for balancing the pressure of the artificial wind was found for any one speed of the whirler, the balance was maintained at all other speeds.

It thus became unnecessary to make any accurate measurements of the rate of revolution of the whirling machine.

Mr. Dines also devised an ingenious arrangement by which the amount of centrifugal force opposing the wind pressure varied automatically, until a true balance was attained. Also since the automatic adjustment did not take place instantaneously, but only by degrees, the disturbance due to natural wind was almost entirely eliminated, and thus experiments were made possible, excepting on days when there was a very high wind.

This is not the place for a full description of the apparatus by which the mechanical principle, explained above, was utilized, but a few words of general explanation are advisable.

The pressure plate was rigidly attached to a short arm, which lay in the same plane as the plate. The other end of the short arm could turn about a pivot which was attached to the long arm of the whirler. When the plate was in position for an experiment, the short arm was in line with the long arm, and the wind pressure tended of course to make the plate turn about the pivot.

The centrifugal force was due to the weight of a horizontal metal bar, at right angles to the long arm of the whirler. This bar could slide through a slot, and when the middle of the bar was at one side of the slot the centrifugal force, due to the revolution of the machine, tended to make the slot turn. The slot was geared to the short arm of the pressure plate by mechanism, which need not be described, so that the centrifugal force reacted against wind pressure. By an automatic action the bar slid through the slot, until, when the weight of the bar was winged out to a certain distance, there was a balance between wind pressure and centrifugal force. Measurement of the distance between the centre of the bar and the slot then gave the amount of force which had been called into play. The tendency of the pressure plate to turn was arrested by two stops, so near together that the plate could only turn through about 1°; it bore on one stop, when the centrifugal force was insufficient for a balance, and on the other when too great. An electrical indicator was devised for detecting on which of the two stops the plate was bearing. An experiment was made by giving a few turns to the machine, and continuing the revolu-

tion until the indicator showed that the plate was bearing on neither stop, or more commonly until it sometimes bore on one stop and sometimes on the other.

For the smaller plates the maximum velocity of which the machine was capable was about 70 miles an hour, but most of the experiments were made at speeds between 20 and 30 miles an hour.

A number of plates and cups of different sizes and shapes were used, and the values given in the following table are the mean of all the experiments made with each particular plate, the number of experiments made with each being given in the last column of the table. Each experiment consisted of about three observations taken in immediate succession. As a rule no plate was tried twice on the same day. With the larger plates a single value seldom differed from the mean by more than 5 per cent., and on the whole the different values were fairly consistent. There were, however, two cases of exception to this statement, and they were the cylindrical surface and the sharp cone when placed in front of the plate. The results of five experiments out of the series of about 150 were rejected.

The particular value of 20·86 miles per hour for the velocity given in the table was chosen for the following reason:—The centre of the pivot about which the pressure plates could turn was 28 ft. 1 in. from the axis of rotation of the whirling machine, and the centre of the plate 28 ft. 7 ins. Taking the numerical value of the acceleration due to gravity as 32·19, these figures give 20·86 miles per hour as the velocity of the centre of the plates at which the centrifugal force acting upon the bar is equal to its weight.

TABLE showing the PRESSURE upon various PLATES at a VELOCITY of 20·86 MILES per HOUR. The Values are reduced to the Standard Temperature and Pressure. The Flat Plates were cut out of Hard Wood $\frac{3}{8}$ in. thick. Allowance has been made for the arm which carried them:—

Plates.	Actual Pressure, in lbs.	Pressure, in lbs. per Square Foot.	No. of Experiments.
A square, each side 4 ins.	·17	1·51	4
A circle, 4·51 ins. diameter, same area	·17	1·51	9
A rectangle, 16 × 1 ins.	·19	1·70	7
A circle, 6 ins. diameter	·29	1·47	7
A square, each side 8 ins.	·66	1·48	8
A circle, 9·03 ins. diameter, same area	·67	1·50	12
A rectangle, 16 × 4 ins.	·70	1·58	4
A square, each side 12 ins.	1·57	1·57	7
A circle, 13·54 ins. diameter, same area	1·55	1·55	14
A rectangle, 24 × 6 ins.	1·56	1·59	6
A square, each side 16 ins.	2·70	1·52	6
A plate, 6 ins. diameter, and $4\frac{1}{4}$ ins. thick	·28	1·45	5
A cylinder, 6 ins. diameter, and $4\frac{1}{4}$ ins. long	·18	0·92	4
A sphere, 6 ins. diameter	·13	0·67	8
A plate, 6 ins. diameter, with a blunt corner angle 90°, at the back	·29	1·49	4

Plates.	Actual Pressure, in lbs.	Pressure, in lbs. per Square Foot.	No. of Experiments.
The same, with cone in front - - -	·19	0·98	4
A plate, 6 ins. diameter, with a sharp cone, angle 30°, at the back - - -	·30	1·54	4
The same, with cone in front - - -	·12	0·60	4
A 5-inch Robinson cup, mounted on 8½ ins. of ⅛-in. rod - - - - -	·28	1·68	8
The same, with its back to the wind - -	·12	0·73	4
A 9-in. cup, mounted on 6½ ins. of ⅛-in. rod - - - - - -	·82	1·75	3
The same, with its back to the wind - -	·28	0·60	3
A 2½-in. cup, mounted on 9¾ ins. of ¼ in. rod - - - - - -	·13	2·60	3
The same, with its back to the wind - -	·05	1·04	3
One foot of ⅝ in. circular rod - - -	·09	1·71	9

The results of the table may be roughly summarized as follows: The pressure upon a plane area of fairly compact form is about 1½ lb. per square foot at a velocity of 21 miles per hour, or in other words, a pressure of 1 lb. per square foot is caused by a wind of a little more than 17 miles per hour.

Experiments were also made with two kinds of plates made of perforated zinc. The pressure on the first kind, which contained about 77 holes of ·08 in. diameter per square inch, was 9 per cent. less than on a solid plate, but gave the high value of 2·43 lbs. pressure per square foot of actual surface. The values for the second kind, having 11 to 12 holes of ·22 in. diameter per square inch, were 20 per cent. less than on a solid plate, and gave about 2 lbs. per square foot of actual surface.

It was necessary to stiffen these plates by turning up the edges, and it was found that this edge when presented to the wind increased the pressure by about 6 per cent.

A cone and a projecting rim, when put at the back of the foot circular plate, caused no appreciable alteration in the pressure, but when the rim projected in front the results were:—

An increase of 6 per cent. with a projection of ⅛ in.
„ 10 „ „ „ ⅜ „
„ 14 „ „ „ ⅝ „

The effect of cutting holes in the foot square plates was also tried —eight circular holes, each of one square inch area, being made, four as near the centre as possible, and one close to each corner. No difference in the pressure could be detected, whether any or all of the holes were covered or open. The eight holes together take away more than 5 per cent. of the plate, yet a difference of 1 per cent. in the pressure, had it existed, would certainly have been apparent.

The pressure upon the same area is increased by increasing the perimeter. The pressure upon any surface is but slightly altered by a cone or rim projecting at the back, a cone seeming to cause a slight increase, but a rim having apparently no effect. This result

is of importance, since a pressure plate for permanent use should be of some material which will not warp, and if thin metal be used a rim is necessary to obtain the requisite stiffness. As might be expected, a cone in front greatly reduces the pressure.

Mr. Dines next determined the moment of pressure upon a 5-in. Robinson cup when placed at different angles to the wind from 0° to 180°. The cup was mounted upon an arm 1 foot in length.

The moment varied as the square of the velocity, so that the same mechanical device as before was again applicable.

The following table gives the moment in feet and pounds when the velocity of the wind is 20·94 miles an hour. The angles are measured, so that when the wind blew straight into the concavity of the cup its incidence is 0°; when it blew across the mouth of the cup it is 90°, and when it blew at the back it is 180°

At angle of	0°	moment	=	·284
,,	12°	,,	=	·292
,,	24°	,,	=	·303
,,	36°	,,	=	·303
,,	48°	,,	=	·317
,,	60°	,,	=	·246
,,	72°	,,	=	·127
,,	84°	,,	=	·048
,,	96°	,,	=	— ·014
,,	108°	,,	=	— ·050
,,	120°	,,	=	— ·046
,,	132°	,,	=	— ·073
,,	144°	,,	=	— ·110
,,	156°	,,	=	— ·116
,,	168°	,,	=	— ·124
,,	180°	,,	=	— ·127

In Sir G. Stokes's bridled anemometer the rotation of the cups is not free as in the ordinary instrument, but is restrained by the action of a spring or weight. The amount of torsion of the spindle which bears the cups is the datum from which the velocity of the wind is deduced. One of these anemometers is under trial at Holyhead.

The instrument ought of course to give constant results from whatever quarter the wind blows, and thus the torsional force required to hold the spindle bearing the cups ought to be independent of the orientation of the wind with respect to the cups. Sir G. Stokes has used Mr. Dines's results with respect to a single cup to determine the inequality, according to orientation, of the action of the wind on a bridled anemometer, consisting of any number of cups from one to six. In Mr. Dines's table, given above, the semi-circumference is divided into 15 equal parts, and accordingly there are materials for computing the action of the wind on an anemometer of one or several cups in 30 different azimuths. It is obvious that if there are several cups, the same

torsional couple is repeated several times over; if, for example, there are two cups, there will be 15 different azimuths, if three, 10 different ones, and so on.

The mean of Mr. Dines's numbers, when repeated so as to go round the whole circumference, is 80, hence the mean couple due to a single cup may be taken as 80. Sir G. Stokes then computed the couple due to pressure on a single cup for the 30 azimuths, with such repetitions as correspond to an anemometer with 1, 2, 3, 4, 5, 6 cups, and subtracted from each the mean couple 80.

For example, when there are six cups, the excess above or defect below 80 is + 12, + 1, − 5, − 12, + 1, repeated six times in all. The sum of these five numbers, regardless of sign, is 31, and their fifth part is 6·2. Hence the average inequality with six cups is represented by 6·2, the mean couple being represented by 8·0. In this way he found that, still taking the mean couple as 80, the average inequality is as follows:—

With 1 cup,	161·5.
With 2 cups,	28·2.
With 3 cups,	19·3.
With 4 cups,	17·2.
With 5 cups,	4·8.
With 6 cups,	6·2.

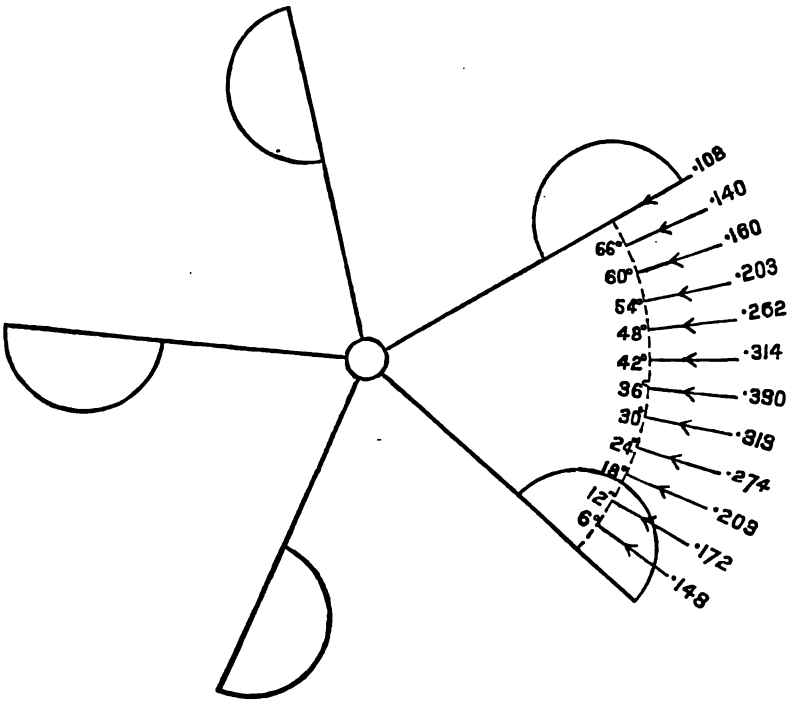
It is obvious that the smallness of these numbers is a measure of the goodness of the instrument as a wind measurer. In designing the instrument, Sir G. Stokes had had an impression that an odd number of cups would be better than an even number, and this appears to be borne out by the numbers. There is naturally a diminution in the inequality with the increase in the number of cups, but this appears to be blended with a superiority of odd to even. Thus 3 cups come out nearly as good as 4, and 5 rather better than 6.

If 6 cups be taken as a superior limit to the number desirable, 5 appears to be the best number to choose.

Sir G. Stokes had been induced to undertake this investigation (which was communicated to the Council in the form of a letter) by some further experiments by Mr. Dines, to which we now return.

Mr. Dines, then, tested an anemometer of five cups, exactly like that at Holyhead, by the same method as that by which he had previously treated the pressure plates. He found that the magnitude of the moment due to the wind was greatly influenced by orientation. The values for positions at intervals of 6° are shown in the annexed diagram, each value being the mean of several observations. The results of the experiments were fairly consistent with one another, the observation for each angle seldom differing by more than three or four per cent. from the mean value.

FIG. 1.



BRIDLED ANEMOMETER.

The figures show the moment, expressed in lbs. and feet, exerted by a wind of 21 *miles per hour. The direction of the wind relatively to the cups is shown by the line against which the figures are placed. In all cases the moment varies as the square of the velocity.*

It was obvious from the consideration of these numbers that the great inequality in the torsional force is not due to the causes considered by Sir G. Stokes, but arises from the interference of each cup with the one partially behind it.

In consequence of these investigations, it was therefore decided to reconstruct the anemometer, retaining five cups in accordance with Sir G. Stokes's views, but re-arranging them spirally on their spindle, so that the interference detected by Mr. Dines should be obviated.

Mr. Dines was then requested to undertake a new series of experiments on the bridled anemometer in its modified form. On the completion of his experiments he submitted the following report to the Meteorological Council :—

"DETERMINATION of the MOMENT of the WIND FORCE upon the
" new arrangement of CUPS of the BRIDLED ANEMOMETER.

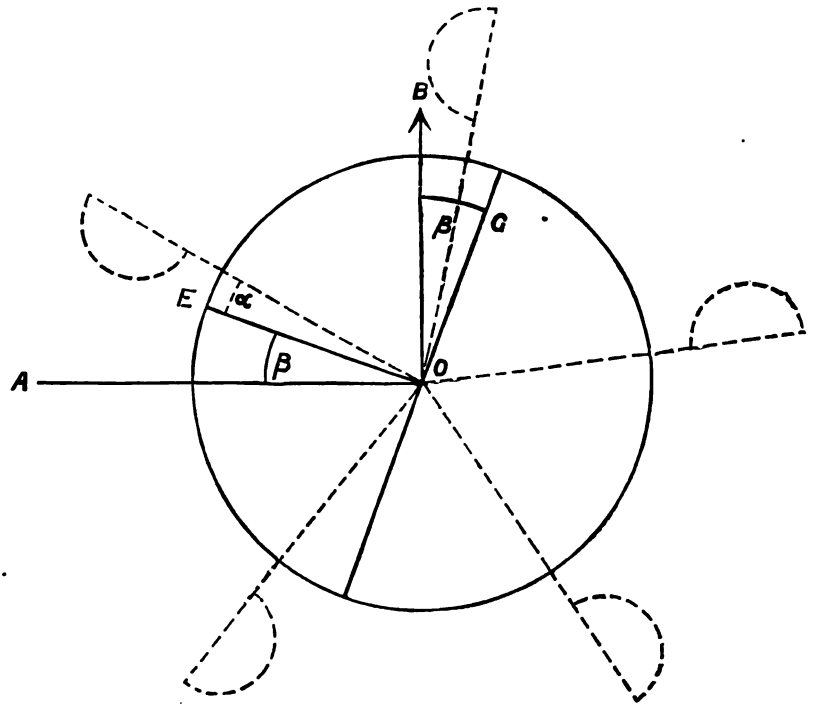
"The instrument consists of five cups, each 5 ins. diameter
" mounted with their centres 7½ ins. from the axis. The cups are

" not in one plane, but are arranged so that there is 1 in. clear " vertical space between the rims of two consecutive cups, and a " difference of 144° azimuth.

" Since the length of the axis rendered it impossible to use the " method which was adopted with the old instrument, the follow- " ing plan was adopted.

" A thin metal disc graduated in degrees round part of its " circumference was made to fit loosely on the bottom of the shaft " of the anemometer, and was provided with a screw by which it " could be clamped in any position. A brass weight was attached " to the disc at 3 ins. from the centre, and at the same distance on " the opposite side of the centre an exactly equal piece of wood " was placed to neutralize the wind pressure upon the brass. The " whole was fitted in a light iron frame so that it could turn freely " about its axis. The frame could be attached to the long arm " of the whirler, so that the axis of the instrument was vertical, " and consequently the disc horizontal.

FIG. 2.



" Suppose *O* to be the centre of the disc, *O A* the direction of " the line joining *O* with the centre of the whirling machine. *O B* " the direction of motion, *G* the position of the weight, and *E* the " zero mark of the graduations, *O G* being at right angles to *O E*.

"Let the angle between $O\,E$ and the vertical plane through one "of the cup arms be α, and the angle $A\,O\,E$, or $B\,O\,G$ be β.

"It is clear that if a sufficient weight be placed at G, the "centrifugal force upon the weight will prevent the complete "rotation of the cups, and that there will be some value of β lying "between 0° and 90° which will be in a position of equilibrium.

"The experiments were made thus:—The disc was clamped so "that α had a certain value, the whirling machine was then rotated, "and soon after a steady velocity had been obtained, a brake was "applied to the disc by a string running from the centre of the "whirling machine, in order that no change of position should be "possible until the reading had been obtained. The machine was "then stopped and the value of B read off to the nearest degree. "The value of $\alpha + \beta$ gave the direction of the wind relatively to "the cups, the moment of the force exerted by the wind at the "instant of applying the brake being proportional to $\cos\beta$.

"In order that the scale might be an open one, a weight was "chosen which gave the position of equilibrium with a small value "of β. If W be this weight the moment due to the centrifugal "force is $\dfrac{W v^2}{g\,(r + O\,G\sin\beta)}\,O\,G\cos\beta$.

"As has been explained in my account of the experiments with "pressure plates, the actual velocity v need not be measured, and "is immaterial to the result, but in these experiments a high "velocity of about 60 miles per hour has been employed to elimi- "nate as far as possible the troublesome error due to the natural "wind. Assuming that the position of equilibrium is taken up "immediately, it will be seen that the natural wind may either "raise or lower the moment as determined by this method. If the "brake be applied when the instrument is moving with the wind "the apparent moment is lowered, and conversely. On the whole, "however, the tendency is to increase the moment, so that the "error cannot be eliminated by taking the mean of a large "number of observations.

"Care has been taken that the brake should not be applied in "any one part of the circle more than in another, and no experi- "ment has been entered which was made at any time when there "was the smallest perceptible wind. Still a wind of two miles per "hour is barely perceptible in the open air, and such a wind "might alter the moment in the ratio of $58^2 : 60^2$, that is, cause "an error of from 6 to 7 per cent.

"About 80 experiments have been made and worked up thus:— "A row of figures from 1 to 72 being prepared, the value of $\cos\beta$ "was taken from a table and placed opposite to the figure indica- "ting the value of $\alpha + \beta$ for the same experiment. In the first "experiments the value of α was chosen at random, but in "subsequent experiments it was chosen so as to fill in the blanks "left in the list as far as possible.

"When the whole set of experiments had been thus tabulated it "was found that the mean value of $\cos\beta$ was ·965, the lowest value

" ·900, and that there was no very marked variation in the value of " cos β in different parts of the list. The figures were pretty " evenly distributed, there being no case of four consecutive " numbers, without at least one value opposite to them.

" The difference in weight of the brass and the facsimile piece of " wood was found to be 6,259 grains, and the distance of the axis " of the instrument from the axis of the whirling machine 28 feet " 11 inches.

" Taking these values for a first approximation we obtain " ·000510 V^2 for the value of the moment expressed in feet and " lbs., V being in miles per hour.

" The experiments were made at temperatures ranging from " 60°—70° F. and mostly between 60° and 65° ; and at a pressure " ranging from 29·80 ins. to 30·00 ins.

" One more correction is necessary ; the cup which was concave " to the wind was inside, and hence the above value is rather too " low. Reference to the table of wind moments for a single cup " in various positions, given in a preceding report, will show that " this correction should be about 1·5 per cent., and hence that " ·0005523 V^2 is the value of the moment due to the wind " pressure upon the instrument. This result is in close agree- " ment with that deduced from the experiments upon a single " cup, and may, I think, be taken as very nearly correct. I " think also that no greater departure than 3 per cent. from " the mean value occurs in any relative position of the wind " direction and the cups.

" W. H. Dines."

Upon the conclusion of these experiments the instrument at Holyhead was dismounted, and it is being reconstructed with the cups arranged spirally on the spindle, as explained above.

The foregoing experiments of Mr. Dines have given such valuable results that the Council have requested him to continue his investigations, with the aid of a further grant of money. This series of experiments was to be on the resistance of plates of various forms at oblique incidences of the wind, and a memorandum of suggestions, as to the line which the experiments should take, was drawn up by Professor Darwin. The account of this work will fall into the annual report of an ensuing year, and it must here suffice to say that the results have proved of the highest interest, and are to be communicated to the Royal Society.*

* A paper containing an account of the experiments was read before the Royal Society on June 19th, 1890.

NOTE C.

Experiments with Violle's Actinometer Apparatus.

The *Boules conjuguées* of M. Violle are an instrument for readily measuring the solar radiation. Like the sun thermometer, as ordinarily used, it gives a relative measurement of the total radiation effect of the sun and sky, in excess of the air temperature, but according to the theory of its action as described by the inventor, with proper precautions, it may be made to furnish that of the solar intensity alone in terms of absolute units. Its principle is the same as that of the blackened and uncoated sun thermometers, used in conjunction, the theory of which has been given by Ferrell, and it is used in the same manner, viz., by exposure to the sun until its temperature has become constant.

It consists of two thin hollow copper spheres, the one coated with lamp black, the other gilt, which surround the bulbs of two thermometers precisely similar in all respects. The interior of the copper spheres and the bulbs of the enclosed thermometers are coated with lamp black. They are exposed to the sun, side by side, and when the temperatures have become constant readings of the two thermometers are taken, and at the same time the temperature of the air is observed with a sling thermometer. From these three observations the radiation coefficient is computed by a simple formula or taken from a table.

Theoretically the excess temperatures of the blackened and gilt spheres above that of the air should bear a constant proportion to each other, both varying directly with the quantity of heat received in the unit of time by radiation. The object of the tests now being applied at Kew is to ascertain whether this condition is fulfilled in practice, or whether such small variations in the coating of the spheres and the enclosed bulbs, in the circumstances of exposure, &c., as are unavoidable with different instruments, or with the same instruments at different times, seriously impair the constancy and comparability of the registers. For this purpose two pairs of spheres are now under trial, and the readings of the four thermometers will be compared with each other to see if their relative values are sensibly constant; whether, in short, the instrument is one that can be placed in the hands of meteorological observers, who have had no special training in a physical laboratory, in the expectation that the results will be more satisfactory than those yielded by the ordinary sun thermometer.

NOTE D.

On the WORK done with the HARMONIC ANALYSER at the METEOROLOGICAL OFFICE.

THE Harmonic Analyser was designed by Sir William Thomson in 1878. Full details of the principle of the instrument will be found in the Proceedings of the Royal Society, Vols. XXIV., p. 262, and XXVII., p. 371; while a description of the machine as constructed for this Office, and also of the method of its employment, is given in Vol. XL., p. 382. Reports as to the method of employing the machine will be found in the Reports of the Meteorological Council for the years 1880, 1881, 1883, and 1885.

The hope was at first entertained that the machine would admit of the labour involved in making the hourly measurements of the photographic traces being dispensed with, and that the harmonic constants could by means of the machine be derived directly from the curves.

For some time after the machine had been delivered at the Office only experimental work was carried on with it, for the double purpose of determining the constants of the machine and the reliability of its results, and also of familiarizing the operator with its use.

The analysis of the thermograms for the year 1876 was first taken in hand, because for that year the mean hourly values of temperature had been calculated, from the published hourly values for the seven observatories, and the data were thus supplied from which the results obtained by the use of the machine could be compared with results obtained by computation. As this was the first operation in which the machine was brought into continuous use, the results were submitted to an examination by Professor Stokes, who instituted "a more searching comparison between the "results obtained by the machine and those got by calculation "than had previously been possible from the available data," with the object of ascertaining whether there was in them any indication of systematic errors, and to what extent they might be relied upon as correct.

The conclusions arrived at, together with the figures upon which they are based, were published by the Meteorological Office in 1884 as an Appendix to the Quarterly Weather Report for 1876, p. [39], the concluding paragraphs of which are as follows:—

"Disregarding now the systematic character of some of the errors, and treating them as purely casual, we get as the average difference between the constants as got by the machine and by calculation from the 24-hourly means 0·065. It may be noticed, however, that the numbers are unusually large (and at the same time very decidedly systematic) in the case of the second cylinder of the first order, for which the average is as much as 0·125, the eighth of a degree. If b_1 be omitted, the average for the remaining cylinders of the machine is reduced to 0·047.

"We see, therefore, that with the exception perhaps of b_1, the constants got by the machine for the mean of the days constituting a month are as accurate as those got by calculation which requires considerably more time, inasmuch as the hourly lines have to be drawn on the photograms, then measured, then meaned, and the constants deduced from the means by a numerical process by no means very short."

While these preliminary trials had been going on it had not been thought expedient to discontinue making the hourly measurements of the curves and publishing the hourly values thus obtained, but hourly means were not computed. At the same time General Strachey, F.R.S., had been occupied in computing the harmonic constants of the entire series of barometric and thermometric observations made at Greenwich for the 20 years between 1849 and 1868, and as he was desirous of obtaining as complete data as possible for comparison with those he had obtained, it was considered that the satisfactory results of the treatment of the photograms of 1876 justified the extension of the use of the machine to the whole series of records of the seven observatories, which in the absence of computed hourly mean values could not otherwise be dealt with.

The analysis of the temperature records for the 12 years 1871–1882 was therefore carried out, and the results were published in 1886 as an appendix to the volume of "Hourly Readings" for the year 1883, in which the harmonic constants of the diurnal march of temperature at each of the seven observatories are given for every month and year of the period.

Subsequently the barograms for the same period were similarly dealt with, but the results have not yet been published.

With a view of obtaining as complete a knowledge as possible of the reliance that can be put on the results derived from the machine, a further set of trials has been carried out by Mr. R. Curtis, which are described in the supplementary note which is annexed.

After careful consideration of the results of this further examination of the operation of the machine, the Council have been induced to modify their former opinions regarding its practical application. For since they have decided to publish the hourly numerical mean values, which are necessarily derived from the measurements of the curves, there is no room to doubt that the harmonic constants can be obtained from these mean values arithmetically with less labour and with greater accuracy than by the use of the machine, while the results can be far more readily and completely checked.

The Council being of opinion that the harmonic analysis of the chief meteorological phenomena should invariably follow the computation of the requisite mean values, they have, for the reasons above stated, resolved that the analysis shall be made by arithmetical computation, while the use of the machine will be reserved for special occasions when its use may be found desirable.

MEMORANDUM by Mr. R. CURTIS.

THE object of these experiments has been to find out how far the actual readings obtained from the harmonic analyser may be relied upon as correct, and to ascertain something of the nature and magnitude of the errors which may be expected to exist in them.

It should be said that at present the only available check upon this portion of the work is to compare the monthly results obtained from cylinder 7 (the mean) with the arithmetical means already obtained from the hourly measurements of the curves. But it is obvious that for the readings of the other six cylinders this test can only be one of the most general character; while as applied to cylinder 7 itself it is by no means so satisfactory as one could wish, since, as these experiments show, the differences between the increments yielded by two tracings of the same curves are often greater than the increments themselves.

The insufficiency of this test has been further shown by these experiments, in having disclosed two important errors in the original operation which the comparison failed to reveal, and which nothing short of re-analysing the curves could be expected to show.

In both instances a temperature curve for one day was passed twice through the machine, and necessarily on both occasions another curve must have been omitted altogether, otherwise the error would have been detected; yet although the error extended in each instance over several days, both escaped detection on comparison with the monthly mean. It is perfectly easy to account for the occurrence of such accidents as these, and bearing in mind the many ways in which they could happen, I think it by no means unlikely that in so large a piece of work as the analysis of the thermograms and barograms, which extends over 12 years records, and involves dealing with an aggregate of upwards of 61,300 days' traces, many of them may exist. It is therefore important to remember that for their detection the comparison of the mechanically and arithmetically derived means is not likely to be of much use.

In the present experiments the thermograms and barograms for Valencia for the year 1877 were again passed through the machine, using the same data for the setting of the machine as on the first occasion, but, in order to guard against the possibility of bias in any direction, not allowing the operator to see any of the original results during the progress of the work. The year 1877 was selected for no other reason than that it was about the middle of the series of years dealt with, and therefore likely to represent a fair average of the work; but it was a

good year to select for the purpose in view for this further reason that it embraced very few cases of defective photography, and those only for short intervals, and therefore the chance that differences would arise from this cause, in the way alluded to later on, was very small.

Thermograms.

Cylinder 7 (mean).—The readings on this cylinder all through the operation were higher than on the first occasion, and the final reading at the close of the year was + 53·685 instead of +48·358, a difference of 5·327 turns of the cylinder. As, however, we deal with *daily* means, these numbers have to be divided by the number of days in the period, and doing this we get a difference of 0°·11 in the mean daily temperature for the year.

In the mean daily temperature obtained from the *monthly* increments we find larger differences between the two operations:—

January = + 0°·3; February, + 0°·25; March, + 0°·21; April, + 0°·04; May, + 0°·02; June, + 0°·02; July, + 0°·02; August, — 0°·005; September, + 0°·07; October, + 0°·06; November, + 0°·12; December, + 0°·18.

It is worth noting here that the differences are large only in the winter months, from April to October they are insignificant, and in August the very trifling difference shown has a minus instead of a plus sign.

The largest differences are of course found between the readings for single days, and the largest of these amounts to 0°·65; the extreme *range* of the differences (from largest + to largest —) amounted to 1°·2.

I think these differences are entirely due to the way in which the curves were traced by the operator on the two occasions, and not to any error in the "setting" of the instrument. Every care was taken to set the ball correctly upon the disc, and if any error had been made here it would have been the same thing as taking an incorrect value for the centre of the disc, which would have given an error constant in sign and amount throughout, which is not what we get.

But to test this point the month of January was passed through the machine a third time, after I had myself examined it to see that the adjustments were good, the zero pointers being then shifted so that an entirely fresh start should be made, as before. In this case the increments were nearly all smaller than in the second operation, though still larger than in the first, the mean daily temperature being 0°·13 lower than the one and

0°·17 higher than the other, a result which I think bears out my suggestion; as I explain further on, the exigencies of the machine make it a difficult task to pass a curve such as a thermogram twice through with exactly the same result.

Cylinders 1 and 2.—In the case of these cylinders the differences were small, the increments being themselves usually very slight; but relatively to the latter they were sometimes considerable, and occasionally as large as the increment itself. The final reading at the close of the operation gave a difference in the daily mean for the year of only − 0°·03 in a_1 and of + 0°·04 in b_1 but as will be seen from the table appended, the daily differences for the months were larger. It is to be noted, however, that the differences varied a good deal in sign, and so tended to cancel each other in the mean.

Some very large differences were found upon examination to be due to the accidental omission of a curve, as already explained.

Cylinders 3, 4, 5, and 6.—Here again the differences are only considerable when they are compared with the size of the increments themselves. The mean daily differences for the year are, in the case of each cylinder, insignificant, but for the month they are sometimes larger. These cylinders were only read at the end of each five days, and it is of course with those readings that the largest differences occur, as, for example, at the close of the first five-day period, when we have—

——	Cylinder 3.	Cylinder 4.	Cylinder 5.	Cylinder 6.
Reading - -	·020	·065	·016	·100
Difference - -	·015	·022	·018	·010

the difference on cylinder 4 being equal to 0°·13.

Barograms.

Cylinder 7 (mean).—The difference between the mean daily pressure for the year, obtained from the final readings of the two operations, is insignificant, but in the daily means for the months the differences are larger, and vary from + ·002 to — ·004 inch. The largest difference between the two readings for any one day is equal to ·026 inch, and these daily differences range from +·026 to −·017 inch. Taking the daily readings of this cylinder as a whole, the differences appear large relatively to the size of the increments, but owing to their constant change of sign they tend to cancel each other as the period over which the mean is taken is lengthened.

Cylinders 1 to 6.—The results here seem to be very similar to those obtained from the re-analysis of the thermograms, and although the differences are all small, yet they frequently bear a considerable proportion to the increments themselves. It is noticeable that there is no indication of any bias on the part of the operator in any one direction, and from this I conclude that the differences indicate fairly the limits within which a set of barograms may be expected upon re-analysis to yield the same results.

In passing a curve through the machine two things have to be attended to: first, the zero line of the curve has to be made to conform to a *fixed* pointer at one end of the cylinder over which the curve is fed; and secondly, a *movable* pointer has to be made to travel over the edge of the trace itself.

In the case of a thermogram the zero is supposed to be a straight line, but practically it is seldom so, owing to an unequal shrinking which occurs in the sheets in drying after completing the photographic process, and which causes a certain amount of curvature in the line known as "bagging." The amount of bagging varies a good deal, sometimes it is very trifling and sometimes considerable.

The zero line of a barogram is the "temperature edge" of the curve, and is not supposed to be straight but to vary with the temperature, owing to the action of the temperature compensation-arrangement of the barograph. In addition to this the curves "bag," as do the thermograms.

The difficulty in dealing with the curves in the harmonic analyser lies in having to keep the two pointers correctly placed at one and the same time. If the zero pointer gets off the line it can only be set right by shifting the sheet, and this has to be done so that it shall then be fed into the machine in such a way that the line shall keep under the pointer for as much of the curve as possible. In doing this there is no room for previous trial as to the effect of the shift before actual working, and although with practice the operator is able to manipulate the sheets in the machine with a good deal of skill, yet it is clear that he cannot always be right, and in any case if the bagging is great the changes have to be frequently made. Besides this there is the risk of his getting considerably off the line before noticing it when his attention is mainly given to following the deviations of the trace with the movable pointer.

It seems to me that here is the weak spot in the machine as we use it. The machine itself leaves little to be desired as regards accuracy of working, as was sufficiently proved long since by the zigzag curves suggested by Prof. Stokes, in which with ordinary care there was no room for error on the part of the operator. The errors now dealt with arise almost solely from the difficulty of following with the necessary accuracy the

edges of the traces, and in the difficulty, almost an impossibility, of ensuring that *both* pointers shall fulfil their functions correctly and continuously lies the chief cause of the differences obtained in passing the same curve twice through the machine.

Another cause of error operating in a similar way is bad photography, since when the curve is very indistinct, it is sometimes impossible to ensure that it shall be followed twice in exactly the same way, and there is always more or less guessing as to what the curve really is.

In addition to this there is the danger of mistake in putting the curves into the machine, the wrong curve may be taken up, or a sheet already in the machine may be used a second time.

And finally, there is the danger of error arising from incorrect reading of the cylinders, or of error in recording the readings upon the sheets.

For errors arising from any of these causes the only checks available, without re-working, are the comparison of the results obtained from cylinder 7 with the arithmetical means, and such check as may be applied by an examination of the readings *inter se.*

VALENCIA, 1877.

Barometer.

Month.	Trial.	First Order.		Second Order.		Third Order.		Mean.
		a_1.	b_1.	a_2.	b_2.	a_3.	b_3.	a_7.
January	1st	+0·0047	−0·0377	+0·0055	−0·0101	−0·0006	−0·0007	29·635
	2nd	+0·0048	−0·0369	+0·0064	−0·0101	−0·0008	−0·0008	29·631
February	1st	−0·0047	−0·0068	+0·0052	−0·0036	−0·0018	−0·0006	29·992
	2nd	−0·0044	−0·0078	+0·0057	−0·0032	−0·0020	−0·0003	29·991
March	1st	+0·0086	−0·0109	+0·0074	−0·0033	−0·0010	+0·0011	29·794
	2nd	+0·0079	−0·0096	+0·0082	−0·0039	−0·0022	+0·0015	29·793
April	1st	−0·0008	−0·0042	+0·0056	−0·0017	0·0000	−0·0017	29·608
	2nd	−0·0018	−0·0044	+0·0059	−0·0022	−0·0001	−0·0015	29·610
May	1st	−0·0010	+0·0031	+0·0055	+0·0038	+0·0013	+0·0021	29·810
	2nd	−0·0008	+0·0026	+0·0062	+0·0031	+0·0003	+0·0019	29·808
June	1st	−0·0075	−0·0153	+0·0073	−0·0096	+0·0020	−0·0059	29·913
	2nd	−0·0078	−0·0153	+0·0079	−0·0099	+0·0012	−0·0055	29·911
July	1st	+0·0016	−0·0068	+0·0048	−0·0020	+0·0018	−0·0011	29·913
	2nd	+0·0016	−0·0068	+0·0059	−0·0025	+0·0013	−0·0012	29·912
August	1st	−0·0091	−0·0091	+0·0057	−0·0027	+0·0018	−0·0016	29·784
	2nd	−0·0094	−0·0091	+0·0055	−0·0029	+0·0009	−0·0009	29·786
September	1st	+0·0008	+0·0070	+0·0098	−0·0034	+0·0019	+0·0011	30·048
	2nd	+0·0008	+0·0058	+0·0098	−0·0043	+0·0013	+0·0014	30·049
October	1st	−0·0018	−0·0060	+0·0073	−0·0098	−0·0010	+0·0028	29·895
	2nd	−0·0023	−0·0065	+0·0063	−0·0095	−0·0009	+0·0023	29·897
November	1st	+0·0117	+0·0289	+0·0092	−0·0022	0·0000	+0·0073	29·546
	2nd	+0·0117	+0·0286	+0·0091	−0·0018	−0·0006	+0·0073	29·548
December	1st	−0·0014	−0·0138	+0·0048	−0·0090	−0·0023	+0·0008	30·010
	2nd	−0·0013	−0·0153	+0·0054	−0·0092	−0·0028	+0·0001	30·009

TEMPERATURE.

Month.	Trial.	First Order.		Second Order.		Third Order.		Mean.
		a_1.	b_1.	a_2.	b_2.	a_3.	b_3.	a_0.
JANUARY	1st	−0°·86	−0°·12	+0°·34	+0°·42	−0°·08	−0°·15	46°·63
	2nd	−0·86	−0·08	+0·38	+0·40	−0·07	−0·13	46·92
	3rd	−0·89	−0·07	+0·38	+0·39	−0·07	−0·14	46·79
FEBRUARY	1st	−0·71	−0·48	+0·29	+0·32	0·00	−0·13	47·50
	2nd	−0·76	−0·47	+0·31	+0·29	+0·01	−0·13	47·74
MARCH	1st	−1·82	−1·26	+0·39	+0·65	+0·01	+0·20	45·41
	2nd	−1·85	−1·30	+0·41	+0·66	+0·01	+0·18	45·62
APRIL	1st	−1·85	−1·72	+0·42	+0·50	+0·08	+0·18	48·59
	2nd	−1·94	−1·77	+0·45	+0·51	+0·11	+0·18	48·64
MAY	1st	−3·14	−2·51	+0·17	+0·11	+0·24	+0·49	51·12
	2nd	−3·02	−2·46	+0·19	+0·12	+0·27	+0·47	51·15
JUNE	1st	−2·74	−1·69	+0·20	+0·22	+0·10	+0·20	57·34
	2nd	−2·74	−1·81	+0·20	+0·25	+0·10	+0·16	57·37
JULY	1st	−2·06	−1·23	+0·16	+0·28	+0·15	+0·15	57·58
	2nd	−2·10	−1·31	+0·18	+0·29	+0·17	+0·13	57·61
AUGUST	1st	−2·22	−1·27	+0·27	+0·41	+0·11	+0·30	58·47
	2nd	−2·26	−1·43	+0·29	+0·41	+0·08	+0·29	58·47
SEPTEMBER	1st	−2·77	−2·22	+0·48	+0·86	+0·13	+0·23	54·95
	2nd	−2·80	−2·32	+0·48	+0·86	+0·12	+0·22	55·02
OCTOBER	1st	−1·52	−0·86	+0·67	+0·50	−0·08	+0·02	53·76
	2nd	−1·57	−0·89	+0·68	+0·51	−0·06	+0·02	53·82
NOVEMBER	1st	−0·82	−0·38	+0·45	+0·46	−0·12	+0·08	48·52
	2nd	−0·83	−0·40	+0·47	+0·45	−0·13	+0·07	48·64
DECEMBER	1st	−0·70	−0·44	+0·50	+0·36	−0·10	−0·30	47·07
	2nd	−0·65	−0·42	+0·45	+0·33	−0·10	−0·29	47·25

APPENDIX.

APPENDIX.

APPENDIX I.

CORRESPONDENCE with H.M. TREASURY about COST of PUBLICATIONS.

(M.O. 480.)

SIR, Treasury Chambers, March 11, 1889.

THE Lords Commissioners of Her Majesty's Treasury have before them a letter from the Controller of the Stationery Office, asking for directions as to the limits within which the demands of the Council for printing, &c., are to be complied with by the Stationery Office without special sanction of this Board.

On reference to the figures given in the annual Estimates, and putting aside the cost of printing the Report, which is about covered by the proceeds of its sale, my Lords find that the average printing expenditure during the last ten years is about 2,400*l.* per annum; the average of the first three years being 1,250*l.*, and that of the last seven 2,850*l.* a year.

The great increase in the expenditure appears to have taken place in 1881–2 and in 1882–3, of the cause of which their Lordships have at present no explanation.

Except in 1884–5, when, as my Lords understand, a special work was issued, the expenditure in each of the last six years appears to have remained without material change.

The expense of this service is so considerable that, before giving instructions as to its supply my Lords will be glad to have before them such observations as the Council may desire to offer as to the probable nature and extent of the future demands for printing, &c. My Lords think it right to state that, if it were contemplated that the annual outlay would further increase, they would have to consider as an alternative, whether it would not be possible to fix a maximum limit for work to be done by the Stationery Office within the year; or to allow to the Council a fixed sum in lieu of the free printing at present enjoyed by them.

In connexion with this subject the Controller of the Stationery Office has called the attention of this Board to an alteration which has recently been made in the size of the Weekly Weather Reports and Charts issued by the Council, whereby the cost of the publication will be raised from 273*l.* to 546*l.*

My Lords will be glad to be favoured with the opinion of the Council as to whether this very considerable increase of cost will be justified by a corresponding advantage to the public.

I am, &c.

(Signed) FRANK MOWATT.

The Secretary of the
Meteorological Council,
116, Victoria Street, S.W.

(P.C. 1511.)

SIR, Meteorological Office, August 6, 1889.

ON receipt of your letter dated the 11th March last, No. 4164, relative to the cost of printing and other work performed by the Stationery Office for the Meteorological Office, the Meteorological

Council took immediate steps for inquiry into the matters specially referred to in that letter.

To enable them to reply to the inquiries of the Lords Commissioners of Her Majesty's Treasury, the Council desired if possible to obtain from the Stationery Office information somewhat in detail as to the cost of the various publications issued from this Office during the years to which special reference is made in your letter. This necessarily occupied some time, and the results have not been such as to admit of any very precise reply being given as to the cause of the increase of expense in printing which is noticed as having taken place in 1881–2 and 1882–3.

The Council have no doubt, however, that the increase of charge after the first three years to which allusion is made was, speaking generally, due to the increased activity at the Office after its re-organisation in 1877. The application of the increased funds placed at the disposal of the Office necessarily involved some expansion of its operations, to meet which those funds were specially assigned; and from the nature of the duties that devolve on the Office, the performance of more work involves an increase in the volume of its publications.

In 1881–2 a change was made in the form of one of the publications of the Office (the Quarterly Weather Report), which involved a large increase to the copper-plate engraving, and was doubtless a cause of increased expenditure; this has now been discontinued. In 1882–3 a special publication was issued relating to the sea off the Cape of Good Hope, which was accompanied by plates, which also must have led to additional charge. In this year, however, the principal increase appears to have been due to the issue during it of publications appertaining to former years, which had fallen into arrear. It is not possible to distinguish properly the yearly cost of the various publications, which in some cases extended over two or more years, and, in the absence of the actual figures, which the Council has not been able to obtain, the best way of judging of this charge will probably be to take as a guide the number of publications issued in the successive years, and their aggregate selling price as fixed by the Stationery Office, which will, no doubt, be some measure of their cost. A statement of this description is annexed, which also indicates the publications which were the most costly.

With reference to the inquiry as to the increased size and cost of the Weekly Weather Report, the Council desire to state that the changes last made were adopted with a view of bringing it more completely up to the standard of information that the present requirements of students of meteorology demand, in relation to the various practical objects and occupations in which the conditions of the weather are important or influential. Among these Agriculture holds a very prominent place, and the reports have been specially framed in communication with persons conversant with the bearing of meteorology on agriculture in view of meeting their wishes.

The attention of the Council having been more particularly directed to this portion of your letter, they have adopted the conclusion that any less full illustration of the conditions of weather over the British Isles and the adjacent countries which influence it, than is now supplied in the Weekly Weather Report, could not be regarded as satisfactory or sufficient, and they deprecate any economy in this direction.

At the same time the Council is fully impressed with the duty imposed upon them of reducing the cost of printing as far as practicable, and they have undertaken a careful revision of their periodical publications, which they have every reason to believe will result in a sub-

stantial reduction of the charge incurred in their behalf at the Stationery Office. The subject will continue to have their attention, and they desire to assure My Lords that every effort will be made on their part to prevent any printing which is not really requisite for the due discharge of the service entrusted to them.

As to the future, the Council have no reason to anticipate any increased demand for printing, but as already mentioned they look to sensible reduction. In modifying the forms of their publications, however, caution is very necessary, and when the revision now proceeding has been completed, they will report its results, and endeavour to supply a standard such as My Lords appear to desire. It may be added that it would assist the Council in controlling this element of expenditure if the Stationery Office from time to time communicated to the Meteorological Office the cost of the work done for it, of which at present it has no means of obtaining any knowledge.

I am, &c.

(Signed) R. STRACHEY,
Chairman of the Meteorological Council.

F. Mowatt, Esq., C.B.,
Assistant Secretary, Treasury.

NUMBER and SELLING PRICE of PUBLICATIONS of the METEOROLOGICAL OFFICE from 1877 to 1887.

Year.	Number.	Aggregate Price.
		£ s. d.
1877	3	3 5 0
1878	2	0 4 6
1879	2	1 1 0
1880	—	—
1881	5	3 8 6
1882	9	19 14 0
1883	5	6 16 6
1884	2	2 13 0
1885	4	8 8 6
1886	2	3 14 6
1887	3	2 8 6

SPECIAL PUBLICATIONS.

		£	s.	d.
1877.	Meteorology of Arctic Regions, 5 Parts - -	1	9	0
1877.	Do. North Atlantic, 31 Charts -	0	15	0
1877.	Quarterly Weather Report, 4 Parts - -	1	1	0
1882.	Do. (8 years) 13 Parts and Appendices -	9	9	0*
1881.	Observations at Stations of Second Order -	1	0	0
1882.	Do. do. -	1	14	6
1884.	Do. do. -	1	15	0
1885.	Do. do. -	1	15	0
1886.	Do. do. -	1	10	0
1887.	Do. do. -	1	12	0

* This charge is spread over several years.

			£	s.	d.
1882.	Hourly Readings of Observations at Special Observatories -	1881, 4 Parts	3	12	6
1882.	Do. do.	1882, 4 Parts	4	8	6
1883.	Do. do.	1883, 4 Parts	4	13	0
1885.	Do. do.	1884, 4 Parts	2	7	6
1886.	Do. do.	1885, 4 Parts	2	4	6
1885.	Weather Charts of Atlantic Ocean, 4 Parts, 33 sheets, each - - - - -		3	8	0
1883.	Sea Temperature Charts - - - -		1	1	0
1887.	Barometric Pressure over Oceans - -		0	10	6
1882.	Meteorological Atlas—British Isles - -		0	5	6
1881.	Rainfall Tables—British Isles - - -		0	7	6

APPENDIX II.

LIST of CAPTAINS (and Officers) who have sent in Logs classed as "Excellent" during the year ending March 31, 1890. The figures opposite to each show the total number of such Logs which they have returned to the Office during the period that they have been observing.

Captain's Name.	Number of "Excellent" Logs.	Ship.
Angus, T. S. - - -	1	S.S. "Canton."
Atkinson, G. W. - -	1	S.S. "Kaisar-i-Hind."
Barker, D. Wilson, F.R.Met. Soc.	12	S.S. "Buccaneer."
Baxter, A. S. - - -	4	"City of York."
Belding, R. - - -	2	"Atlantic."
Bennett, E. C. - - -	14	"Thessalus."
Blackburn, Mr. H. S. - -	7	S.S. "Rohilla."
Bolton, S. H. - - -	9	S.S. "Baidar."
Briscoe, R. F. - - -	3	S.S. "Kaisar-i-Hind."
Cameron, J. G., R.N.R. -	5	S.S. "Adriatic."
Cameron, Sub-Lieut. A. C. L., R.N.	1	H.M.S. "Stork."
Campbell, H. - - -	9	S.S. "Ardangorm."
Campbell, J. - - -	7	"Glengarry."
Campbell, R. - - -	3	S.S. "Elton."
Clapp, Staff Comr. E. S., R.N.	10	L.H. Tender "Richmond."
Couper, William - -	2	"Clackmannanshire."
Crighton, A. T. - -	5	SS. "Circe."
Cromarty, D. S. - -	3	"Cassandra."
Crotty, F. H. - - -	4	"Evesham Abbey."
Crowley, C. - - -	3	"Alexander Lawrence."
Crutchley, W. C., R.N.R. -	19	S.S. "Kaikoura."
Dark, S. - - -	3	"Blairgowrie."
Dart, L. C. - - -	10	"Semantha."
Dawson, Comr. L. S., R.N. -	8	H.M.S. "Rambler."
De Horne, M. - - -	1	S.S. "Rohilla."
Docherty, H. - - -	1	"Baron Colonsay."
Drenning, W. B. - -	1	S.S. "Mira."

Captain's Name.	Number of "Excellent" Logs.	Ship.
Dunbar, J. I. - - -	17	S.S. "Arracan."
Dyke, A. H. - - -	3	S.S. "Don."
Dyke, H. W. - - -	8	"Accrington."
England, T. - - -	8	"Jane."
Exham, T. K., F.R.A.S. -	6	S.S. "Esk."
Field, Lieut. and Comr. A. M., R.N.	4	H.M.S. "Dart."
Fraser, W. D. - - -	4	"Thomas S. Stowe."
Fullarton, D. - - -	5	"Timaru."
Garnsworthy, T. - -	1	S.S. "Ardancorrach."
Gillies, W. - - -	1	S.S. "Medway."
Gray, J. - - -	13	S.S. "Hope."
Halley, E. - - -	4	"City of Madras."
Helby, Lieut. H. W. H., R.N. -	1	H.M.S. "Myrmidon."
Hicks, G. M. - - -	2	S.S. "Nile" and S.S. "Neva."
Hird, W. - - -	5	"Marlborough."
Irving, P. J., R.N.R. - -	8	S.S. "Celtic" and S.S. "Germanic."
Jennings, R. C. - -	3	S.S. "Colina."
Jones, S. Griff - -	8	"Hermine."
Kemp, A. H. - - -	3	"Hudson."
Kiddle, Sub-Lieut. E. W., R.N.	5	H.M.S. "Egeria."
King, J. W. - - -	4	"Philomene."
Leportier, T. - - -	9	S.S. "Mira."
Long, Mr. J. C. - -	6	S.S. "Kaisar-i-Hind."
McFee, J. R. - - -	3	"Great Victoria."
McLean, A. - - -	8	S.S. "Concordia."
Marshall, F. - - -	5	"Berkshire."
Mesnard, T. - - -	8	"Sierra Miranda."
Millican, J. W. - -	4	"Myrtle Holme."
Milne, W. F. - - -	7	S.S. "Esquimaux."
Milner, W. H. - - -	8	S.S. "Avon" and S.S. "Neva."
Mitchell, G. - - -	1	S.S. "Trinacria."
Moignard, P. - - -	4	"Astoria."
Molony, E. J. - - -	8	"British Merchant."
Munn, L. A. - - -	2	S.S. "Durban."
Murdoch, P. - - -	10	"Sierra Lucena."
Newton, Mr. T. C., F.R.Met. Soc.	8	S.S. "Minia."
Norman, F. - - -	7	"John O'Gaunt."
North, W. G. - - -	12	S.S. "Tiger and S.S. "Plato."
Oldham, C. F., R.N. - -	9	H.M.S. "Egeria."
Owen, O. - - -	1	S.S. "Cordelia."
Parry, Moses, F.R.Met.Soc. -	15	S.S. "Prydain."
Parsell, H. - - -	12	S.S. "Britannic."
Parson, G. F. - - -	9	"Earnock."
Pasifull, E. J. - - -	1	"Rahane."
Pearson, C. W. - -	29	S.S. "Strathleven."
Pope, J. - - -	2	S.S. "Derwent."
Powles, F. W. - - -	6	S.S. "Essequibo."
Price, J. H. - - -	4	"Viola."
Pullen, Commr. T. F., R.N. -	1	H.M.S. "Stork."

Captain's Name.	Number of "Excellent" Logs.	Ship.
Randall, W. - - -	11	"Laomene."
Read, G. W., F.R.G.S. -	5	S.S. "Auretta."
Richardson, Mr. W. H. -	4	S.S. "Auretta."
Rigaud, H. C. - - -	2	S.S. "Derwent."
Ritchie, A. - - -	2	"Four Winds."
Rosseter, W. L. - -	11	"Columba."
Russell, C. J. - - -	10	"Belfast" and "Holkar."
Saul, J. - - -	1	"Coronilla."
Scott, W. - - -	20	"Winifred."
Shearer, G. - - -	10	"Thetis."
Sibery, H., R.N.R. - -	2	S.S. "Clan Cameron."
Simpson, A. - - -	11	S.S. "Australasian."
Simpson, A. - - -	19	S.S. "Traveller."
Smith, W. C. - - -	11	"John R. Worcester."
Spooner, I. D. - - -	3	S.S. "La Plata."
Spratly, W. - - -	14	S.S. "Mozart."
Stewart, A. - - -	1	"County of Selkirk."
Sturdee, H. K. - -	12	L.H. Tender "Richmond."
Thearle, J. - - -	1	S.S. "Lennox."
Thompson, J. E. - -	2	S.S. "Monarch."
Thompson, Lieut. H., R.N. -	2	H.M.S. "Rambler."
Thomson, A. S. - -	10	S.S. "Silvertown."
Tizard, Staff-Capt. T. H., R.N.	9	H.M.S. "Triton."
Travers, H. C. - - -	7	S.S. "Tartar."
Trevor-Roper, Dr. G. D., R.N.	1	H.M.S. "Stork."
Trott, S., F.R.Met.Soc. -	16	S.S. "Minia."
Trunks, H. - - -	4	"Aldborough."
Vereker, Hon. F. C. P., R.N. -	9	H.M.S. "Myrmidon" and H.M.S. "Rambler."
Wait, A. M. - - -	4	S.S. "Spartan."
Walker, H. - - -	11	S.S. "Servia."
Wheaton, N. J. - -	10	"Eliza."
Wilson, J., R.N.R. - -	4	S.S. "Ethiopia."
Woolward, R. - -	5	S. S "Nile."
Worrall, W. A. - -	1	"Camana."

Names of deceased observers printed in italics.

APPENDIX III.—Ships supplied and Documents returned during the year ending 31st March 1890.

The number of merchant ships supplied with standard instruments and meteorological logs during the above period was 114.

The number of meteorological logs, and documents from Foreign Stations, received during the same period, and registered in the Office, amounted altogether to 353, of which 216 were returned from ships, and the remainder from land stations, outside the British Isles.

List of Documents received from Foreign Land Stations.

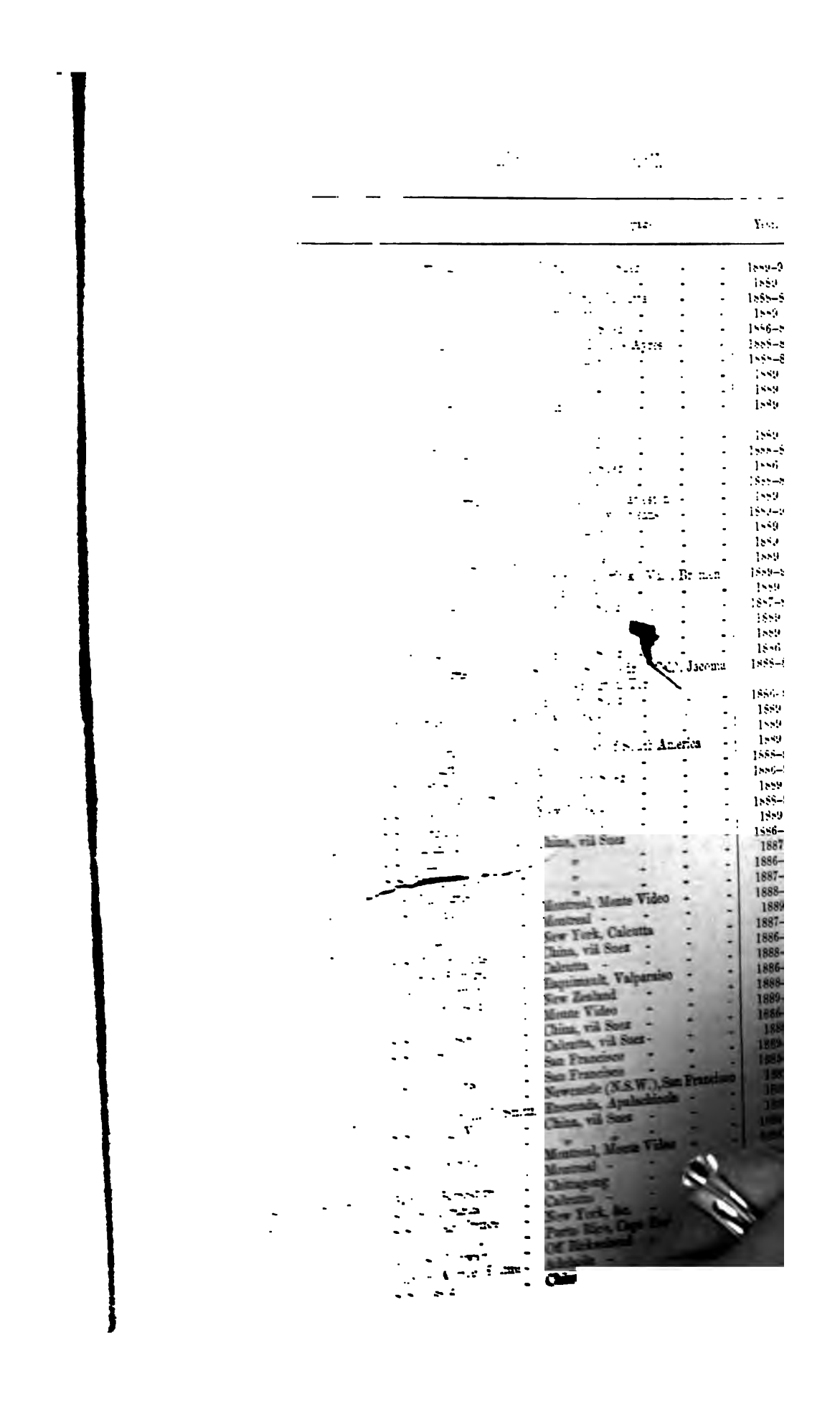
Place.	Observer.	No. of Documents.	Nature of Observations.
Abaco (Bahamas)	T. R. Thompson, Lightkeeper	1	"Lighthouse" Register, 1889, January to June.
Akassa, Nun River, Niger Delta	Frank Russell, F.R.G.S.	5	Two observations daily, 1889, May to November.
Bathurst (Gambia)	I. M. Harrison, E. J. Burt, and E. Allen.	1	„ „ „ October 1887 to September 1888.
Beyrout (Lee Observatory)	R. H. West, M.A.	12	„ „ „ February 1889 to February 1890.
Cape Juby (N. W. Africa)	Hubert Bray	3	„ „ „ October 1889 to January 1890.
Cape Pembroke (Falkland Islands)	G. K. Broom, Lightkeeper	2	"Lighthouse" Register 1889, January to December.
Cay Lobos (Bahamas)	N. H. E. Garner and J. G. Maura, Lightkeepers.	2	„ „ 1889, January to December.
Cay Sal (Bahamas)	T. R. Thompson, Lightkeeper	3	„ „ 1888, July to December. 1889, January to December.
Famagusta (Cyprus)	G. Eliades	2	Two observations daily, 1888, January to December.
George Town (British Guiana)	Robert Ward	11	„ „ „ 1889, March to December, 1890, January.
Gibraltar	Staff-Sergeant H. Spuckman, Med. Staff Corps.	12	„ „ „ February 1889 to January 1890.

LIST of DOCUMENTS—*continued.*

Place.	Observer.	No. of Documents.	Nature of Observations.
Grand Bassam - - -	A. Jouve and G. Baillan, West African Tel. Co.	3	Two observations daily, 1888, April to September; 1889, February; 1890, February.
Heligoland - - -	J. J. Friederichs, Lightkeeper	12	" " " March 1889 to February 1890.
Inagua (Bahamas) - -	B. N. Jones and R. A. A. Espie, Lightkeepers.	2	"Lighthouse" Register, 1889, January to December.
Kapalama (Honolulu) - -	Henry Cobb Adams -	11	Two observations daily, 1889, February to December.
Kyrenia (Cyprus) - -	M. Fuleiham - -	2	" " " 1888, January to December.
Larnaca (Cyprus) - -	G. P. Voudiziano - -	2	" " " " "
Limassol (Cyprus) - -	Luigi Béraud - -	2	" " " " "
Nicosia (Cyprus) - -	G. Stephen and C. Carletti -	2	" " " " "
Papho (Cyprus) - - -	E. A. Malliotis - -	2	" " " " "
Principe Island (West Africa) -	E. Hurdus - - -	2	" " " August 1889 to January 1890.
São Thomé (West Africa) -	E. Hurdus - - -	2	" " " 1888, December; 1889, January and February.
Suva (Fiji) - - -	J. D. W. Vaughan, F.R.Met. Soc.	8	One observation daily, 1887, July; 1888, April to December; 1889, January to December.
Teneriffe (San Antonio) - -	W. L. Boreham (the late), and A. F. Perry.	10	Two observations daily, March 1889 to January 1890.
Tobago - - - -	J. P. Tulloch, M.A., M.B. -	10	" " " 1889, March to December.
Trinidad - - - -	J. H. Hart, Supt. Botanic Gardens.	11	" " " January 1889 to January 1890.
Watling Island (Bahamas) -	S. W. Hall, Lightkeeper -	2	"Lighthouse" Register, 1889, January to December.

LIST of DOCUMENTS received from SHIPS.

Captain's Name.	Ship.	Voyage.	Year.
Anderson, Charles	S.S. Achilles	China, viâ Suez	1886–87
[1] Angus, T. S.	S.S. Canton	Bombay, viâ Suez	1889–90
[2] Armstrong, B. G.	S.S. Elbe	Brazil	1889
Asquith, W.	S.S. Deucalion	China, viâ Suez	1886–88
[3] Atkinson, G. W.	S.S. Kaisar-i-Hind	Calcutta, viâ Suez	1889
Barker, D. W., F.R. Met. Soc.	S.S. Buccaneer	Pernambuco	1889
,, R. J. M.	Earl of Aberdeen	Calcutta	1888–89
Batt, H.	S.S. Hector	China, viâ Suez	1886–88
Baxter, A. S.	City of York	Sydney, Sourabaya (Java)	1888–89
Belding, Rawstin	Barque Atlantic	River Plate	1889
Bennett, E. C.	Thessalus	San Francisco	1888–89
Bennet, J. T.	Alcester	Calcutta	1888–89
Bigley, W. B.	S.S. Diomed	China, viâ Suez	1886–88
Bolton, S. H.	S.S. Baidar	Ports in the Baltic, France, Spain	1889
,, ,,	,,	Spanish Ports	1889–90
Bragg, I. T.	S.S. Antenor	China, viâ Suez	1886
[3] Briscoe, R. F.	S.S. Kaisar-i-Hind	Bombay, China, viâ Suez	1889
Brown, R. J.	S.S. Titan	China, viâ Suez	1886–88
Buckler, J. H.	S.S. Dee	West Indies	1888–89
,, ,,	S.S Solent	,, ,,	1889
Butler, S. H.	S.S. Priam	China, viâ Suez	1886
Cameron, Hugh	S.S. Ardangorm	Havana, Baltimore	1889
,, ,,	,,	Havana, New Orleans	1889–90
,, John	S.S. Thetis	Odessa, Antwerp	1888
[4] ,, J. G., R.N.R.	S.S. Adriatic	New York	1888–89
[5] ,, ,,	,,	,,	1889
Campbell, James	Glengarry	Calcutta	1889–90
[6] Campbell, Robert	S.S. Elton	Rangoon, viâ Suez, Spezzia	1889
Carse, James	Barque Firth of Solway	Sydney	1888
Chrimes, Henry	S.S. Sarpedon	China, viâ Suez	1886–88
[7] Clapp, Staff-Comr. E. S., R.N.	Schooner Richmond	Bahamas	1889
[8] ,, ,,	,, ,,	,,	1889–90
[9] Conby, H. B.	Garfield	New York, Calcutta	1889–90
[10] ,, ,,	Gilcruix	Calcutta, New York	1888
Couper, William	Clackmannanshire	New Caledonia	1888–89
Crighton, A. T.	S.S. Circe	Baltimore	1888–89
[11] ,, ,,	,,	Montreal	1889
Cromarty, D. S.	Barque Cassandra	Autofagasta, New York	1888–89
Crotty, F. H.	Evesham Abbey	Mauritius, Calcutta, New York	1886–89
Crowley, C.	Barque Alexander Lawrence.	Rio Janeiro, New York	1889
[12] Crutchley, W. C., R.N.R.	S.S. Kaikoura	Cape Town, New Zealand, Rio Janeiro	1888–89
[12] ,, ,, ,,	,,	Wellington, N.Z.	1889
[12] ,, ,, ,,	,,	Wellington, viâ Cape Town, Rio Janeiro	1889–90
Dark, S.	Blairgowrie	Sydney, San Francisco	1888–89
Dart, L. C.	Barque Semantha	San Francisco	1888–89
Davies, David	Andora	Albany (W.A.), Calcutta, San Francisco, Sydney (N.S.W.)	1888–89
[13] Dawson, L. S., R.N.	H.M.S. Rambler	China Sea, Port Darwin	1889
[13] ,, ,,	,,	N.W. Coast of Australia	1889
[14] De Horne, M.	S.S. Rohilla	Bombay, viâ Suez, Hong-Kong	1889
[15] ,,	,,	Calcutta, viâ Suez	1889–90
[16] Dickinson, L. R.	S.S. Atrato	East Coast of South America	1889–90
Docherty, Hugh	Baron Colonsay	Singapore	1888–89
[10] Drenning, W. B.	S.S. Mira	Calcutta, viâ Suez	1889
Dunbar, J. I.	S.S. Arracan	Rangoon, viâ Suez	1889
,, ,,	,,	,, ,,	1889



	Captain's Name.	Ship.	Voyage.	Year.
	Milligan, Samuel -	S.S. Jason - -	China, viâ Suez - - -	1886
	" " -	S.S. Stentor - -	" " - - -	1887–88
28	Milne, W. F. -	S.S. Esquimaux -	St. John's (Newfoundland) -	1889
	Milner, W. H. -	R.M.S. Avon - -	West Indies - - -	1889
	" " -	" - -	" - - -	1889
	" " -	S.S. Neva - -	Brazil - - - -	1889–90
	Mitchell, George -	S.S. Trinacria -	Mediterranean Ports, New York -	1888–89
	" " -	" - -	New York, Palermo, New Orleans	1889
	Moignard, P. -	Barque Astoria -	Sydney, San Francisco - -	1888–89
	Molony, E. J. -	British Merchant -	Calcutta - - - -	1889
29	Munn, L. A. -	S.S. Durban - -	Cape Town - - -	1889
	Murdoch, Peter -	Sierra Lucena - -	Bombay - - - -	1888–89
	Nelson, R. - -	S.S. Menelaus - -	China, viâ Suez - - -	1886–88
	Nish, H. - -	S.S. Cyclops - -	" " - - -	1886–88
	Norman, Francis -	Barque John O'Gaunt -	Hobart, Valparaiso - -	1888–89
	North, W. G. -	S.S. Plato - -	Hamburg - - - -	1889
	" "	S.S. Tiger - -	" - - -	1889
30	Oldham, Comr. C. F., R.N.	H.M.S. Egeria -	Australian Station - -	1889
30	" "	" -	" - -	1889
31	Owen, Owen -	Barque Cordelia -	Callao, Havana - - -	1888–90
	Parry, Moses -	S.S. Prydain - -	Mediterranean Ports - -	1888–89
	" " - -	" -	Constantinople, Rio Janeiro, Santos, New Orleans - - -	1889–90
32	Parsell, H. - -	S.S. Britannic - -	New York - - -	1888–89
10	Parson, G. F. -	Earnock - -	Melbourne - - -	1888–89
	Pasifull, E. J. -	Rahane - -	San Francisco - - -	1889–90
	Pattman, R. -	Loch Torridon -	New York, Calcutta - -	1888–89
	Paul, John - -	Barque Glenogle -	Callao - - - -	1889
33	Pearson, C. W. -	S.S. Strathleven -	New York, China, viâ Suez -	1888–89
	Pike, A. - -	Walrus sloop Siggen -	Spitzbergen - - -	1888–89
34	Pope, James -	S.S. Derwent - -	West Indies - - -	1889
34	" " -	" " -	Barbados - - - -	1889
	Powles, F. W. -	S.S. Essequibo -	West Indies - - -	1889
	" " -	" -	" - - -	1889
10	" " -	" -	" - - -	1889
	Price, J. H. - -	Barque Viola - -	Vancouver Island - -	1888–89
	Pulford, J. - -	S.S. Patroclus - -	China, viâ Suez - - -	1888
35	Pullen, Comr. T. F., R.N.	H.M.S. Stork - -	Zanzibar, viâ Suez, Simon's Bay -	1888–89
	Purdy, T. - -	S.S. Dardanus - -	China, viâ Suez - - -	1886–88
	Randall, W. -	Laomene - -	New York, Batavia - -	1888–89
36	Read, G. W., F.R.G.S.	S.S. Auretta - -	Colombo, viâ Suez - -	1889
37	Reynolds, Robert -	S.S. German - -	Cape Town - - -	1888–89
37	" " -	" - -	" - - -	1889
34	Rigaud, H. C. -	S.S. Derwent - -	West Indies - - -	1888–89
38	" " -	S.S. Tamar - -	Brazil - - - -	1889
	Riley, J. - -	S.S. Ajax - -	China, viâ Suez - - -	1886–88
	Ritchie, Alexander -	Four Winds - -	Melbourne, Calcutta - -	1888–89
	Rossiter, W. L. -	Columba - -	Calcutta - - - -	1888–89
	Russell, C. J. -	Belfast - -	" - - - -	1889
	" " -	Holkar - -	" - - - -	1889
18	Sargent, A. H. -	Gleniffer -	Nelson, N.Z. - - -	1889
	Saul, John -	Barque Co -	Valparaiso, Hamburg - -	1888–89
	Seale, R. P. -	S.S. [illegible] -	China, viâ Suez - - -	1886–88
	Scott, William -	Barque [illegible] -	Trinidad - - - -	1889
	Shearer, George -	[illegible] -	[illegible] Ayres - - -	1888–89
	Sibery, Harry -	[illegible] -	[illegible]wn, Madras, Port Said -	1889
39	[illegible]	[illegible]	[illegible]n, Madras, home, viâ Suez	1889–90
	[illegible]	[illegible]	[illegible], via Cape, home, viâ [illegible] - - - -	1889
	[illegible]	[illegible]	[illegible], viâ Cape, Singapore, [illegible]iâ Suez - -	1889
	[illegible]	[illegible]	[illegible]d - - - -	1889
	[illegible]	[illegible]	[illegible]nhithe - - -	1889
	[illegible]	[illegible]	[illegible], San Francisco, Sydney -	1887–89

	Captain's Name.	Ship.	Voyage.	Year.
[40]	Spooner, J. D.	S.S. La Plata	Brazil	1889
[41]	„ „	„	„	1889
	Spratly, W.	S.S. Mozart	Rio Janeiro, New York, Monte Video	1888–89
[42]	„	„	Monte Video	1889–90
	Storm, A.	Barque Seiriol Wyn	Sydney, San Francisco, Melbourne	1887–89
	Stewart, Alexander	County of Selkirk	Calcutta	1889–90
	Streater, Rowland	Barque Lutterworth	New Zealand, Portland (Oregon)	1888–89
[30]	Symons, F. J., R.N.R.	S.S. Moor	Cape Town	1888–89
	Thearle, J.	S.S. Lennox	China, viâ Suez, New York	1888–89
	Thompson, A.	S.S. Patroclus	China, viâ Suez	1886
[43]	„ J. E.	S.S. Monarch	Coast of British Isles	1889
	„ J. S.	S.S. Nestor	China, viâ Suez	1886–88
	Thomson, A. S.	S.S. Silvertown	S.W. Coast of Africa	1889
	Tizard, Staff-Capt. T. H., R.N.	H.M.S. Triton	Coasts of British Isles	1886–89
[44]	Travers, H. de la Cour	S.S. Tartar	Cape Town	1888–89
[44]	„ „	„	Cape of Good Hope	1889
[45]	Trott, Samuel	S.S. Minia	North Atlantic	1889
[45]	„ „	„	Halifax	1889
[45]	„ „	„	„	1889–90
	Trunks, H.	Barque Aldborough	Singapore, Bassein	1889
[46]	Vereker, Hon. F. C. P., R.N.	H.M.S. Myrmidon	Sydney, Manila	1888
[13]	„ „	H.M.S. Rambler	China Sea, Port Darwin	1889
[47]	Wait, A. McLean	R.M.S. Spartan	Cape Town	1889
[47]	„ „	„	„ „	1889
	Walker, Henry	S.S. Servia	New York	1889
	Webster, J. K.	S.S. Prometheus	China, viâ Suez	1886–87
	Wheaton, N. J.	Barque Eliza	St. Domingo	1888–89
	„ „	„	Mexico	1889
	Wilding, J.	S.S. Agamemnon	China, viâ Suez	1886–88
	Wilson, John, R.N.R.	S.S. Ethiopia	New York	1889
[48]	Woolward, Robert	R.M.S. Nile	West Indies	1889
[48]	„ „	„	„ „	1889–90
	Worrall, W. A.	Barque Camana	Buenos Aires, Taltal (Chili)	1889–90
[49]	Young, H.	S.S. Circassia	New York	1888–89

In cases distinguished by marginal numbers the Meteorological Registers were kept chiefly by Officers, as follows:—

[1] Kept by W. W. Cooke, 2nd Officer, W. C. Pickering, 3rd Officer, Percy Gibson, 4th Officer.
[2] Kept by W. Fish, 2nd Officer, J. Murray, 3rd Officer, and J. Bloy, 4th Officer.
[3] Kept by J. C. Long, Chief Officer.
[4] Kept by H. I. Haddock, R.N.R., and E. W. Burnett.
[5] Kept by E. W. Burnett, L. Scott, and J. T. Shenton.
[6] Assisted by G. W. Plane and G. Burt.
[7] Kept by H. K. Sturdee and F. W. Holden.
[8] Kept by F. W. Holden.
[9] Kept by 3rd Mate.
[10] Assisted by Officers.
[11] Assisted by John Dickie, 2nd Officer.
[12] Kept by J. L. Berryman, 4th Mate.
[13] Kept by Lieut. H. Thompson, R.N.
[14] Kept by H. S. Blackburn, 1st Officer, and C. C. Talbot, 2nd Officer.
[15] Kept by 4th and 5th Officers.
[16] Kept by W. E. Moses, 4th Officer.
[17] Kept by H. C. Miles, 3rd Officer.
[18] Kept by W. H. Jones, Signalman.
[19] Kept by H. Lamont, 2nd Officer.
[20] Kept by J. V. Williams, 4th Officer.
[21] Kept by James Adams, 2nd Officer.
[22] Kept by Arthur Clarke, 3rd Officer.
[23] Kept by I. J. Lossius.
[24] Kept by T. B. O'Brien, R.N.R., H. J. Haddock, R.N.R., and J. C. Carr, R.N.R.
[25] Assisted by J. E. Browne, Chief Officer.
[26] Assisted by Messrs. Belson, Huchinson, and Peterson.
[27] Kept by the Cadets.
[28] Assisted by J. Brown.
[29] Kept by R. H. Saoh, 3rd Officer.
[30] Kept by Lieut. E. B. Kiddle, R.N.
[31] Assisted by M. N. Anderton, Mate.
[32] Kept by J. Christie.
[33] Assisted by G. R. Berwick, 2nd Mate.
[34] Kept by H. W. Beal, 2nd Officer.
[35] Kept by Sub.-Lieut. A. C. L. Cameron and G. D. Trevor-Roper, Surgeon.
[36] Kept by W. H. Richardson, 1st Mate.
[37] Kept by A. H. Rhodes.
[38] Kept by C. E. Down, 2nd Officer.
[39] Assisted by Robert Stirling, 2nd Officer.
[40] Kept by George Adams and C. P. Langmaid.
[41] Kept by George Adams, 4th Officer.
[42] Assisted by T. Lloyd.
[43] Kept by A. F. Halpin, 3rd Officer, assisted by F. Alford and C. J. Hall, 2nd Officers.
[44] Kept by J. Bowyer, 2nd Officer.
[45] Kept by T. C. Newton, 1st Officer.
[46] Kept by Lieut. H. W. H. Helby, R.N.
[47] Kept by R. G. Jackson.
[48] Kept by F. S. Newton, 2nd Officer.
[49] Kept by J. Adams, 2nd Officer.

APPENDIX IV.

INSTRUMENTS supplied, &c. to the Royal Navy.

Per Account.	Barometers.	Aneroids.	Thermometers.				Hydrometers.
			Ordinary.	Max.	Min.	Screens.	
April 1st, 1889, afloat - -	190	455	1,255	262	227	142	78
Issued since - -	98	165	397	70	65	40	26
	288	620	1,652	332	292	182	104
Returned since - -	77	140	324	43	34	15	51
April 1st, 1890, afloat -	211	480	1,328	289	258	167	53

INSTRUMENTS supplied, &c. for use at Naval Stations.

April 1st, 1889, in use -	59	64	192	17	18	3	12
Issued since - -	2	5	52	6	4	8	1
	61	69	244	23	22	11	13
Returned since - -	—	6	36	2	1	8	2
April 1st, 1890, in use -	61	63	208	21	21	3	11

DISPOSITION of ADMIRALTY INSTRUMENTS on April 1st, 1890.

Afloat in Royal Navy - -	211	480	1,328	289	258	167	53
In use at stations - -	61	63	208	21	21	3	11
In store at M.O. - -	15	67	390	87	109	38	49
,, Chatham - -	6	6	26	8	6	2	13
,, Sheerness - -	5	5	18	7	7	5	9
,, Portsmouth -	11	33	51	10	13	10	9
,, Devonport -	14	29	37	7	6	2	20
,, Queenstown -	2	5	21	1	1	—	8
,, Gibraltar - -	2	2	14	—	—	—	4
,, Malta - -	4	7	4	—	2	—	17
,, Bombay - -	4	3	12	4	4	1	4
,, Halifax - -	3	10	16	2	3	—	14
,, Bermuda - -	4	16	24	1	6	—	15
,, Jamaica - -	3	3	19	2	2	—	—
,, Cape of Good Hope	2	7	20	6	5	3	8
,, Trincomalee -	4	3	21	4	4	—	—
,, Hong Kong -	6	21	32	15	12	—	17
,, Coquimbo -	2	5	23	1	2	—	19
,, Sydney - -	3	6	13	6	4	—	—
,, Esquimalt - -	8	9	26	3	3	—	—
Total, April 1st, 1890 -	370	780	2,303	474	468	231	270
Lost, &c. since April 1st, 1889	1	12	202	23	8	12	16
Under repair - - -	35	—	—	—	—	—	—

APPENDIX V.

INSTRUMENTS supplied, &c. to Mercantile Marine.

Per Account.	Barometers.	Compasses.	Thermometers.				Hydrometers.
			Ordinary.	Max.	Min.	Screens.	
April 1st, 1889, afloat - -	116	—	699	—	—	120	379
Issued since - - -	88	—	532	—	—	79	275
	204	—	1,231	—	—	199	654
Returned since - -	97	—	595	—	—	93	312
April 1st, 1890, afloat - -	107	—	636	—	—	106	342

INSTRUMENTS at Stations, viz., Telegraph Offices, Observatories, Fishing Villages, &c.

April 1st, 1889, in use - -	256	3	275	58	58	36	10
Issued since - - -	15	1	11	1	1	3	1
	271	4	286	59	59	39	11
Returned since - -	15	—	39	4	2	4	—
April 1st, 1890, in use - -	256	4	247	55	57	35	11

DISPOSITION of Board of Trade Instruments on April 1st, 1890.

In merchant ships - -	107	—	636	—	—	106	342
In use at stations - -	256	4	247	55	57	35	11
In store at M.O. - -	39	2	198	19	55	8	98
At Liverpool Agency -	10	7	52	—	—	8	44
„ Aberdeen „ -	2	—	18	—	3	4	8
„ Glasgow „ -	3	—	29	—	—	3	29
„ Dundee „ -	13	—	15	—	—	11	28
„ Hull „ -	8	—	30	—	—	6	26
„ Southampton „ -	8	—	39	—	—	8	30
„ Cardiff „ -	—	—	—	—	—	—	—
Total, April 1st, 1890 -	446	13	1,264	74	115	189	616
Lost, &c. since April 1st, 1889	8	—	186	3	3	31	91
At opticians - - -	26	—	14	—	—	—	2

APPENDIX VI.

List of Stations reporting Meteorological Observations to the Office by Telegraph on 31st March 1890, with the Names of Observers.

*†Sumburgh Head	Rev. W. Brand	Minister of Dunrossness.
*†Stornoway	J. Forbes	Nicolson Institution.
Wick	J. Sinclair	Watchmaker.
Nairn	Miss Penny	Schoolmistress.
*†Aberdeen	W. Boswell	Assistant at the Observatory.
Leith	W. Hay	Telegraph Clerk.
*†Shields	J. W. Irvine	Do.
Spurn Head	J. H. Watson	Lightkeeper.
†York	H. M. Platnauer, F.G.S.	Curator of Museum.
Loughboro'	W. Berridge	
†Ardrossan	J. W. Mayes	Telegraph Clerk.
Malin Head	O. O'Doherty	Signalman, Lloyd's.
*†Mullaghmore	K. Kerr	Retired Coastguard Officer.
*†Belmullet	Miss M. J. Tolan	Telegraphist.
†Donaghadee	T. MacGowan	Postmaster.
Parsonstown	E. Haines	Assistant Observer at Lord Rosse's Observatory.
*†Holyhead	Capt. Richards	Keeper of Sailors' Home.
Liverpool	J. Hartnup, F.R.Met.Soc.	Bidston Observatory.
*†Valencia	J. E. Cullum, F.R.Met.Soc.	Superintendent of the Observatory.
†Roche's Point	W. Kennedy	Telegraph Clerk.
Pembroke	S. Blake	Lightkeeper.
*†Scilly	A. Hicks§	Signalman.
Prawle Point	W. Hewitt	Coastguard Officer.
†Hurst Castle	G. G. Appleton	Lightkeeper.
†Jersey	J. Fisher	Station Master.
*†Dungeness	W. Batton	Assistant Lightkeeper.
*†London	F. Gaster, F.R.Met.Soc.	Clerk, Meteorological Office.
Oxford	W. Wickham	Radcliffe Observatory.
Cambridge	H. Todd	Observatory.
*†Yarmouth	G. T. Watson	Secretary, Sailors' Home.
‡Hawes Junction	W. H. Bunce	Station Master.

In addition to the above reports are received daily from the following Continental Stations.

Station.	Authority.	Station.	Authority.
Haparanda	Meteorological Office, Sweden.	†The Helder	Bureau Central Météorologique, Paris.
Hernösand		Cape Gris Nez	
†Stockholm		†(Brest, St. Mathieu)	
Wisby		Lorient (Île de Groix)	
Bodö	Meteorological Institute, Norway.	*†Rochefort (Ile d'Aix)	
†Christiansund		†Biarritz	
*†Skudesnaes		†Paris	
Faerder		Belfort	
		Lyons	
		Nice	
†The Scaw	Meteorological Institute, Denmark.	Perpignan	
Fanö		Berlin	Cent. Met. Inst. of Germany.
		Wiesbaden	
Cuxhaven	Deutsche Seewarte, Hamburg.	Munich	
		Corunna	Observatory, Lisbon.
		†Lisbon	

Note.—Those stations marked with an asterisk (*) report also at 2h. p.m.; and those with a dagger (†) at 6h. p.m.; Lisbon reports at 8h. a.m. and 4h. p.m.

‡ This station now reports by post only.

§ W. Thomas died in March 1890.

The reports from Barrow-in-Furness ceased at end of 1889.

APPENDIX VII.

Report of Inspections, Ireland and Wales.

Gentlemen,

I have to report that I have completed the inspection of the Irish and Welsh stations, and have also visited the fishery barometers which lay in my way.

Telegraph Stations.

Holyhead, visited August 6.—I found this station in good order. No remarks are called for.

Donaghadee, visited August 7.—This station was also satisfactory. I regret to say the health of the observer is not good.

Malin Head, visited August 12.—The new observer, Owen O'Doherty, is more satisfactory than his predecessor, J. Farren, and I hope that the station will now be useful. The instruments were in good order.

Mullaghmore, visited August 13.—This station was, as usual, in very good order.

Belmullet, visited August 15.—The instruments were all in good order and the station satisfactory.

Valencia, visited August 22, and found in good order. I authorised some necessary repairs to be carried out at the observatory.

Roche's Point, visited August 26.—The instruments were in fair order; the wet bulb was not satisfactorily mounted.

Parsonstown, visited August 28.—The observer, Haines, is attentive, and does his duty well.

St. Ann's Head, visited September 2.—This station was in good order.

Stations of the Second Order and Weekly Weather Report Stations.

Armagh, visited August 8.—Dr. Dreyer was absent, but I saw Mr. Faris, his assistant. The instruments were in proper order.

Colebrooke, visited August 9.—The instruments were in order. It is possible that this station may be discontinued.

Londonderry, visited August 9.—The station calls for no remark.

Markree, visited August 14.—The station was, as usual, in good order.

Currygrane, visited August 17.—The new assistant, F. Warrington, continues to work well.

Killarney, visited August 24.—The observer was absent, but the substitute was efficient and the instruments in good order.

Foynes, visited August 27.—These observations are only carried on while Lord Monteagle is residing at the place.

Parsonstown, visited August 28.—The observer, Sergeant Whelan, is failing in health.

Dublin (*Fitzwilliam Square*), visited August 29.—The station continues in excellent order.

Dublin, Glasnevin, visited August 29.—The only matter calling for remark is that the new gauge which was supplied in 1888 shows a larger fall than the old one, owing to difference of situation. I have directed the observer to discontinue the use of the old gauge.

Dublin, Mountjoy, visited August 29.—The only matter calling for notice is that it has been found that the anemometer, though on a high stage, registers 40 per cent. less than Holyhead.

Kilkenny, visited August 30.—The instruments were in good order, but there is no prospect of the station becoming one of the Second Order.

Waterford (*Brooklawn*) visited August 31.—This station, like Foynes and Kilkenny only takes readings for the Weekly Weather Report.

St. David's, visited September 3.—This station was, as usual, quite satisfactory.

Llandovery, visited September 4.—This also is only a station for the Weekly Weather Report; as such, it is fairly satisfactory.

I visited also certain fishery barometers which lay on my route. These were Ballyglass (Broadhaven), Ballycastle (Co. Mayo). Howth, Malahide, Hakin (Milford), and Angle, Milford Haven. At the last-named station the barometer has been exposed to weather. The instrument is serviceable if not moved about.

At several of these stations lectures would be appreciated.

(Signed) ROBERT H. SCOTT.

The following table shows the results of the thermometric comparisons:—

Corrections to be applied to the readings of—

STATIONS.	Dry Bulb.	Wet Bulb.	Max.	Min.	Spare Therm.	Remarks.
STATIONS OF THE SECOND ORDER.						
Armagh	−0·3	−0·5	−0·9	—	—	Grass min. 2°·5 of spirit separated.
Brookeborough	−0·2	−0·7	−0·1	+0·2	—	
Dublin (City)	−0·3	−0·4	−1·1	−0·3	—	
Dublin (Phœnix Park)	−0·9	−1·0	−0·3	−0·3	−1·0	Grass min. −1·6.
Edgeworthstown	−0·5	−0·3	−0·3	+0·6	—	Do. +0·7.
Glasnevin	−0·6	−0·5	−1·0	0	—	Do. −1·0.
Londonderry	−0·3	−0·2	+0·2	+0·3	−0·3	
Markree Castle	−0·7	−0·7	−0·2	−0·1	—	
Parsonstown	−0·8	−0·1	−0·8	−0·3	—	
St. David's	−0·7	−0·7	−0·4	−0·1	—	
TELEGRAPHIC REPORTING STATIONS.						
Holyhead	−0·2	−0·4	−0·6	−0·1	−0·6	
Malin Head	−0·1	−0·9	+0·1	−0·3	−0·4	New observer:
Mullaghmore	−0·5	−0·6	−0·4	+0·4	−0·6	
Belmullet	−0·6	−0·5	−0·4	−0·5	—	
Donaghadee	−0·8	−1·1	−1·1	−0·4	−0·7	
Parsonstown	−0·8	−0·1	−0·8	−0·3	—	
Valencia	−0·8	−0·5	−0·5	−0·1	+0·2	
Roche's Point	−0·9	−0·8	−0·8	+0·2	—	
St. Ann's Head	−0·2	0·0	0·0	+0·3	−0·1	
WEEKLY WEATHER REPORT STATIONS.						
Londonderry	−0·4	−0·3	+0·1	+0·2	−0·4 Grass. Ther.	
Armagh	−0·4	−0·6	−1·0	?	−0·3	Casella's mercurial min.: −not read. 2·5 of spirit separated in grass. min. − ther.
Colebrooke	−0·3	−0·8	−0·2	+0·1	—	
Markree	−0·7	−0·7	−0·2	−0·1	—	
Edgeworthstown	−0·5	−0·3	−0·3	+0·6	— Grass Min.	
Dublin	−0·3	−0·4	−1·1	−0·3	−0·3	
Kilkenny Castle	—	—	0·0	−0·2	—	
Waterford	−0·7	−0·8	+0·1	+0·2	—	
Killarney	−0·2	−0·2	−0·1	+0·2	—	
Foynes	−0·7	—	−0·5	+0·3	—	
Llandovery	—	—	−1·5	0·0	—	

Report of Inspection of the Scottish Stations for 1889.

Barometers.

The inspector's mercurial Standard Barometer No. 690 was used for this year's inspection tour. The results of the inspection of the station barometers are given in the following table. The barometers were found to be in good order, and continue to be observed with the same care and accuracy as in former years.

Stations.	Inspector's Standard, corrected.	Not corrected.		Remarks.
		Rep. Baro.	Check Baro.	
	ins.	ins.	ins.	
Fort William	29·680	29·680	—	
Fort Augustus	29·945	29·943	—	
Glencarron	29·237	29·237	—	
Stornoway	29·908	29·904	29·901	
Swanbister	29·678	29·688	—	
Dunrossness	29·560	29·554	29·558	
Wick	29·186	29·180	29·142*	* Read 15 min. later in house at higher level.
Nairn	29·560	29·558	29·559	
Aberdeen	29·715	29·715	29·712	
Braemar	28·891	28·878	—	
Dundee	29·734	29·730	—	
Ardrossan	30·026	30·020	—	
Pinmore	29·986	29·982	—	
Glenlee	29·736	29·748	—	
Leith	29·264	29·260	—	
Marchmont	29·118	29·118	—	
Ochtertyre	29·415	29·424	—	

Thermometers.

The thermometers in use at the stations were compared in water with Standard Thermometer No. 4433. The following table gives the corrected readings of the standard thermometer and the errors of each instrument as determined by the comparisons.

Stations.	Standard No. 4433, corrected.	Dry Bulb.	Wet Bulb.	Spare Thermometer.	Max. Thermometer.	Min. Thermometer.	Time in Water in Minutes.	Change of Temperature.	Remarks.
	°	°	°	°	°	°		°	
Fort William	57·8	0·0	+0·2	—	+0·2	−0·1	40	Uniform	
Fort Augustus	58·3	+0·1	+0·1	—	0·0	−0·4	60	Do.	
Glencarron	57·1	0·0	−0·1	—	0·0	−0·2	90	Do.	
Stornoway	57·6	+0·5	+0·6	+0·4	−0·2	−0·4	150	Do.	About 0°·2 of min. ther. at top of tube. Put right.
Swanbister	59·1	+0·1	+0·1	+0·8	−0·2	−0·4	90	+0·2	
Dunrossness	59·2	+0·4	+0·4	—	+0·2	−0·9	200	+0·2	
Wick	58·6	+0·4	+0·4	—	−0·3	−0·4	70	Uniform	
Lairg	57·0	+0·2	+0·2	—	−0·2	0·0	60	Do.	
Nairn	55·8	+0·7	+0·7	+0·1	0·0	+0·9	80	+0·3	In reading 1°·0 is subtracted from min.
Aberdeen	56·3	+0·2	+0·1	—	0·0	+0·1	90	Uniform	
Braemar	55·3	+0·5	+0·4	—	0·0	−0·1	70	Do.	
Dundee	58·7	+0·5	+0·5	—	+1·3	−0·3	90	+0·4	
Ardrossan	51·5	+0·2	+0·3	—	−0·2	−0·2	120	Uniform	
Pinmore	50·6	+0·2	+0·4	—	−0·1	+0·1	90	+0·2	
Glenlee	51·5	+0·2	+0·2	—	−0·3	0·0	140	Uniform	
Leith	50·0	+0·1	+0·4	—	+0·1	−0·6	50	Do.	
Marchmont	51·0	−0·2	−0·2	—	0·0	0·0	225	+0·5	
Ochtertyre	49·9	0·0	0·0	—	+0·6	0·0	130	Uniform	

As requested by the Office, the minimum thermometers were very specially examined, and only at Stornoway was this instrument found out of order. The quantity which was lodged in the top of the tube directly under the clamp was only 0°·2. This was rectified in presence

of the observer, who was at the same time instructed how to put it right if it should in future get out of order.

Neither the maximum nor minimum thermometer at Dunrossness is etched on the stem. As regards the minimum thermometer, the fiducial points 32°, 62°, and 92° are only very slightly above the corresponding points of the attached scale, certainly not more than two-tenths. The large error of this thermometer, about a degree, is therefore due to a faulty construction, or to some change in the mass of the fluid, or internal capacity of the tube since its graduation. Both this station and Nairn should be supplied with new minimum thermometers. At Nairn the practice has been to subtract a degree from each reading of the minimum thermometer, whereas at Dunrossness, where the error is equally great, the readings are telegraphed as made.

Hygrometers.

Again on this inspection, the dry and wet bulbs were read instantly on opening the thermometer screens, and in all cases the arrangements for correct hygrometric observations were satisfactory.

Notes on the Stations.

Fort William, August 6, 1889.—The instruments were all in good order and observed correctly and with care.

This is the low-level station at which observations have been made five times daily by Mr. Livingstone since the opening of the Ben Nevis Observatory in 1883.

The building of the low-level observatory was in progress, and it was expected that it would be finished about the end of October. A delay of from three to four weeks has been occasioned by the drought of last summer, owing to which the stones brought from Elgin could not be conveyed through the Caledonian Canal, but had to be taken round Cape Wrath to Fort William.

Fort Augustus, August 7.—The instruments were in excellent order and observed with great care and intelligence. The one or two omissions of observations, which recently occurred were occasioned by the new official duties of Father Martin. In future all the observations will be taken by the new observer, Father Cody. A new sunshine recorder has been erected in an excellent position.

Glencarron, August 9.—Everything, including the Richard thermograph and barograph, were in excellent order, and well read and attended to. A new sunshine recorder has been erected, constructed for the latitude, and with the usual three stages. The house of Glencarron shelters the instrument from the sun before setting behind the hills about midwinter; and during the summer months the sun sets behind the hills about 6 p.m.; but the exact times will be observed in the course of the year.

Stornoway, August 12.—As the clamp of the minimum thermometer is just over the top of the tube, any evaporated spirit lodged here cannot be seen. A gas flame was applied to it and the result showed that two-tenths had been evaporated. All the other instruments were in good order, and very well observed.

A misunderstanding on the part of Mr. Forbes had seriously limited the number of cases of variations of pressure inserted in his daily telegraphic reports. He now quite understands what is wanted and how to handle the aneroidogram, so that his daily report will show the more

marked changes of pressure, and the non-instrumental phenomena of storms, for which the help of his assistants and others will be enlisted.

Swanbister, August 14.—The instruments were all in the best order, and very accurately observed.

Dunrossness, August 17–19.—Everything was in excellent order, and the observations are made with great care and accuracy. Neither the maximum nor the minimum thermometer has its stem engraved. As regards the minimum, which reads nearly a degree too low, the three fiducial scratches on the stem are each about 0°·2 above these readings; the instrument has therefore been in error from the beginning.

Wick, August 20.—The instruments were in very good order, and the observations taken by both observers with accuracy and despatch. The rain-gauge had been recently repaired and is now in good order.

Lairg, August 21.—The instruments were removed in May from their old positions to the house and garden of the new observer, Mr. Young, of the public schools. The new positions are very good. A new rain-gauge and supports for the thermometer screen are required, which will shortly be supplied, otherwise the instruments were in good order and are well observed. The height of the new station is 335 feet.

Nairn, August 22.—The instruments were in excellent order, and the observations well taken by all the observers.

Aberdeen, August 24.—All the instruments were in very good order and are well observed.

Braemar, August 27.—The instruments are well kept and observed. Since, however, they have been in use for the long period of 33 years, it is desirable that some changes and repairs be made, which are now being attended to.

Dundee, August 28.—The instruments continue to be thoroughly well kept, and the observations carefully and correctly made.

Ardrossan, September 30.—The Stevenson screen required pretty extensive repairs and repainting, which were ordered to be done. The rain-gauge has been repaired, but is not quite firmly fixed, this was to be done on the following day. Otherwise the instruments were in good order, and very intelligently observed. On the two days when the wet bulb was found to be dry, the cup of the hygrometer had been upset. The observer was told what to do should this recur. As Mr. Mayes is now settled in Ardrossan, satisfactory arrangements will shortly be made for making the 10 p.m. observation. The new assistant read the instruments correctly, and made up the telegram also correctly.

Pinmore, October 1.—The instruments were all in excellent order, and are very carefully observed. As explained in previous reports, this station is situated in a rather deep valley, only from 150 to 300 yards in breadth, and virtually shut in on all sides. The instruments are in an open position in the garden, but all round there is much fine old wood. Thus the prevalent calms are a striking feature of this limited district, as also are the rapid fall of temperature in the early evening and the rather frequent frosts.

Glenlee, October 2.—The instruments were in particularly good order, and are observed with much care and intelligence.

Leith, October 10.—The supports of the thermometer screen and the enclosure for the instruments require to be repaired and repainted, and orders were given to have this done. Otherwise the instruments were in very good order, and the observations are made with much care and intelligence.

Marchmont, October 11–12.—All the instruments were in particularly good order, and the observations are made with intelligence and accuracy. The following additional instruments are at this station:—Maximum and minimum black bulbs; a minimum thermometer suspended outside the thermometer screen; three underground thermometers; a second rain-gauge, 12 inches square, with its rim 15 inches high; a glycerine sunshine recorder, designed by Mr. Loney, and an aneroidograph.

Ochtertyre, October 17.—All the instruments were in singularly good order, and observed with great care and intelligence. The following additional instruments are at this station:—A complete set of duplicates of thermometers and rain-gauge; three underground thermometers at depths of 3, 12, and 22 inches; maximum and minimum exposed thermometers.

(Signed) ALEXANDER BUCHAN.

REPORT of INSPECTION of the ENGLISH STATIONS, 1889.

TELEGRAPHIC REPORTING STATIONS.

Dungeness, inspected June 7.—There appears to be some improvement in the observations taken at this station, but the wet-bulb thermometer was dirty and the bulb itself much crusted with lime. I found, by testing, that the water used on the day of my visit was hard. There is a rather large difference between the corrected readings of the reporting and check barometers, but the first-named instrument is correct. I question whether the lowness of the barometric readings, as frequently reported from this station, is due to carelessness on the part of the observers. As regards the low temperatures sometimes reported from Dungeness, I adhere to my opinion that these are correct, and are principally due to the character of the soil. The Dungeness temperatures give a very inadequate idea of the climatology of the neighbouring coast. The exposure of the station is, however, excellent.

Jersey (*St. Aubin's*), June 9.—The reports from this station continue to be very good. The situation of the sunshine recorder was at the time of my visit not very satisfactory. The instrument was sheltered in early morning and late evening in summer; and the extreme steepness of the slope on the summit of which it was situated, rendered it necessary for the observer to employ a substitute to attend to the instrument. I subsequently received a letter from Mr. Fisher, suggesting a new site, half-way between St. Aubin's and St. Brelade's, at the summit of the hill leading down into the latter village, where the exposure would be perfect, in the garden of a lady who promised to take charge of the instrument. After some correspondence, a personal friend in whose skill in such matters I have full confidence, the Rev. H. W. P. Yorke, of St. Helier's, removed the instrument to the new situation on November 20th.

I notice that, as anticipated, the summer maxima are higher than those reported when the thermometers were at Noirmont.

Hurst Point, June 12.—The instruments at this station were in good order. The thermometer screen much needed repairs and repainting, which has since been done. The observer still continues every now and then to make inaccurate reports.

Scilly (*St. Mary's*), June 15 and 16.—The observer, Mr. Thomas, was somewhat ill and unequal to taking accurate observations at the

date of my visit. I gave careful instructions to the observer's son (who frequently attends to the observations), as to reports of changes of pressure indicated by the self-recording aneroid, a matter of some importance at this station. Mr. A. Hicks continues to be at any time ready to assist in or to conduct the observations.

A new block was needed for the rain-gauge and was ordered.

The anemometer was in as good working order as usual, giving occasionally blurred anemographs, owing to the saltness of the water particles in the atmosphere. One of the clock wheels required much rubbing with emery, and needs more frequent lubricating. This I attended to.

Prawle Point, June 18.—The observations at this station, for which Mr. Mehegan seems to be almost entirely responsible, are very accurate, and are carefully reported. The minimum, No. 307, again contained exactly 0°·9 of detached spirit, a defect which had only recently recurred and for which the observer had applied a correction. By refrigerating the bulb and applying strong heat to the other end of the tube, I rectified the defect for the time.

Spurn Head, July 12.—The instruments at this excellent station are in good order, and the new lightkeeper appears to attend to them carefully, and to read them with accuracy. The station would be as faultless a one as could be found on our coasts, were it not for the drifting of the dry sand around the outdoor instruments.

Barrow-in-Furness, July 19.—Mr. Whitworth was absent from home on the day of my visit. The thermometers were in good order, but the wet-bulb was not clean. I only succeeded in expelling an exceedingly small bubble of air from the barometer tube. This tube has been since refilled and has been employed again since August 1st. A new rain-gauge had been substituted for the old one previously to my visit. The instrument is a good one and has a fair exposure. As regards the winds felt at this station, I may be permitted to refer back to previous inspection reports.

North Shields, July 24.—The barometers were in good order. They will probably have to be removed from their present site in the course of the coming winter, as new post office buildings are being erected. I have given full instructions as to their removal.

Dockwray Square is now open to the public, and is much employed for tennis. Children frequently meddle with the rain-gauge and have already injured it. The observer, Mr. J. Irvine, recommends that the outdoor instruments should be shifted towards the south-west corner of the Square, where they will be at a much safer distance from the entrance gate. I would suggest that the gauge should be surrounded by an iron fence, similar to that employed at York and some other places. Except this Square there appears to be no place in the immediate neighbourhood available for the outdoor observations.

York, July 26.—The barometer No. 156, employed as the reporting instrument at this station was last year supposed to be out of order, and No. 138 was sent down for employment either instead of, or to check, the readings of the former instrument. The observer reported No. 138 to be also out of order. I found both 156 and 138 to be in perfect order. I recommend that the old barometer should be retained as a reporting barometer, and No. 138 as a check for the present; but it will perhaps be better that No. 138 should eventually be used as the reporting instrument.

Yarmouth, September 18.—The observations taken at this station continue to be in all respects satisfactory, and I found all the instruments in good order.

Cambridge, September 18.—The instruments were all in good order. The low wind velocities characteristic of this station are, in all probability, as I have previously mentioned, the result, to a great extent, of the wooded character of the country round Cambridge.

Oxford, September 19.—The reports from this station are very good, and I found all the instruments in a satisfactory condition. There is a slight deposit on the wet-bulb.

Loughborough, September 27.—The observer had to leave his house on business almost immediately after my arrival, and I therefore could not on this occasion compare his readings of the instruments with my own. The standard barometer having been conveyed in a warm railway carriage and omnibus, had a much higher temperature when suspended than the reporting barometer at the station. I had also to suspend the former out of doors, not finding a place which I liked to avail myself of within the house, and the sun shone occasionally on part of the instrument. At the time of comparison the attached thermometer of the standard read 3°·9 higher than that of the reporting barometer. Correcting to equivalent temperatures the standard read 0·021 in. above the observer's instrument, but as I do not consider the comparison satisfactory I have entered no figure in the table. All the other instruments were in good order, and no observer could be more punctual and painstaking than Mr. Berridge. The thermometer corrections are not in accordance with my expectations.

The following, which are not Telegraph Reporting Stations, were inspected by me this year.

Eastbourne, June 8.—The observations at this station are good, and I found all the instruments to be in excellent order. The sunshine recorder has been raised 1 foot and erected on the middle of the turret (instead of on one side) upon a substantial pedestal. The observer undertook to send the readings of the solar radiation thermometer on overcast days, which had not hitherto been done. The station, which is in the hands of the Town Council, seems likely to be permanently maintained.

Plymouth, June 13.—Dr. Merrifield was absent at the time of my visit. The instruments were in good order. The rain-gauge occupies a much better site than that which it had at the Navigation School. The sunshine recorder had a very fair, but not absolutely perfect, exposure. It required a trifling adjustment. The old screen is in use, and is a wall screen. The observations appear to be carefully conducted.

Prestwich, July 13.—Dr. Clunn, who superintends the observations for this station, was much engaged at the time of my visit, and the observer who usually takes the readings was absent. The returns from this station unfortunately continue to be greatly in arrear. The barometer is correct. The outdoor instruments are excellently situated. The thermometers were compared in 1878 in melting ice, and the corrections then obtained were assumed to vary as the old Kew corrections throughout the scale, but at 55° the 1878 corrections are (if my comparisons this year were correct) inapplicable.

Isle of Man (*Cronkbourne*), July 21.—Mr. Moore was absent at the time of my visit. His deputy takes the observations with great accuracy. The instruments were in excellent order, with the exception of the grass minimum, the tube of which contained 2°·7 of detached

spirit, which I restored. Mr. Murphy had applied an additive correction of 2° since noticing the defect. The returns from this station are good.

Isle of Man (*Douglas, Prospect Hill*), July 22.—Since my inspection of this station in 1887 all the outdoor instruments have been moved to a new site about 70 yards from their former position, but on the same level. The ground now occupied by them affords an improved, though not absolutely perfect, exposure. The barometer is not a reliable instrument. It had at the time of my visit a considerable error, but I re-adjusted the tube on the scale so that it read correctly when I left the station. The thermometers were in good order; and the returns appear to be carefully attended to.

Newton Reigny, July 22.—This is a most excellent station. All the instruments were in admirable order, and the returns are very complete and accurate. The sunshine recorder has an almost perfect exposure. Mr. Benn and his assistant are most careful in the attention bestowed on the observatory.

Seaham, July 25th.—The instruments at this station were found to be in good order, except that there was a considerable deposit on the wet bulb, the muslin of which requires to be very frequently changed, The corrections of the dry and wet-bulb thermometers, as determined by me this year, differ from those obtained in previous years, but the old corrections may advantageously be retained for the present. A new door was required for the screen, which also needed to be re-painted. Mr. Aird had the repairs attended to directly after my visit. The returns from this station are satisfactory.

Durham, July 25.—I found all the instruments at the observatory in very good order, except the grass minimum, which contained 1°·3 of detached spirit. A correction of this value has been in use. The returns from Durham are good and complete.

York, July 25 and 26.—The thermometers were in good order. The returns from the station are fairly good. I do not, however, consider the observer to be entirely trustworthy as regards punctuality and accuracy.

The sunshine recorder is still kept at the Friends School, Bootham. There is some little difficulty in getting it well and punctually attended to during the vacations, but the records are on the whole satisfactory. Mr. R. Thompson expressed his willingness to take the instrument into his own charge at his new residence (Dringcote), should the change be considered desirable. The question may, I think, be deferred till next inspection.

Oswald Kirk.—The sunshine recorder at this place is the property of Mr. R. Thompson. It is well attended to, but the exposure is not quite perfect.

Epsom, September 17.—It being still vacation at the Royal Medical College, the observer was absent. His substitute appeared to require a little instruction in reading the barometer. The instruments were in good order. Errors of reading and reduction are still noticeable in the returns from this not unimportant station. The barometer, when the correction for index error has been employed, reads ·009 too low.

Rugby, December 9.—The returns from this station are still of little value, as the a.m. readings of the barometer are not punctually taken, and the outdoor observations are left to Mr. Kirk, the gardener, whose observations of wind and cloud appear to me of no value. He reads the thermometers well; and all the instruments (except the rain-gauge,

which is nearly worn out) are in excellent order. The barometer is inconveniently situated. I have advised that the rain-gauge be shifted to the south-east of its present position (where it is slightly sheltered), and be repaired. I have but little hope that the returns from this station can, at least for some years to come, be usefully employed, as the school arrangements interfere with the punctual performance of the meteorological work.

Sutton Coldfield, December 31.—The returns from this station have been until lately considerably in arrear, but there is, I think, every prospect of their now being punctually attended to. There has been some falling off in punctuality since Mr. Fletcher left the station. However, Mr. Marston, the new observer, promised me to pay full attention to the work. His assistant, Mr. J. H. Smythe, read the instruments with great accuracy. The Jordan's sunshine recorder is on the south corner of the roof of the municipal buildings; it has an admirable exposure, but the time-lines do not seem correctly printed. Barometer is a Fortin by Bailey of Birmingham. It is certified as having a very small error, but at 29·80 it read ·005 lower than my standard. The outdoor instruments were situated in Mr. Fletcher's garden, where the position is very good. Mr. Marston informed me that they would shortly have to be moved into his own garden, where the position is by no means so well exposed. The removal actually took place, as I am informed, on January 6th. The observer promised to have the screen, which has hitherto been of a green colour, painted white on the date of its removal.

The following table gives the results of the comparisons made by me in 1889, and contains its own explanation. The barometer employed by me as a standard up to July 24th was the contracted Adie No. 216. The tube up to the time of its unfortunate breakage at Newcastle remained free from air. After that date I employed as a standard the uncontracted Adie No. 590, which has also kept in excellent order. The results of the thermometric comparisons may be, I think, regarded as fairly satisfactory. The rain-gauges were all found in good order except in those cases mentioned in this report. The same remark may be made of the sunshine recorders. But to these latter instruments I intend to devote a separate and minute investigation in the course of the present year. At one station only of those this year inspected was the barometer tube found to contain air. In three only was the thread of spirit in the minimum thermometer found to be broken, and in none of these had the defect escaped the observer's attention. Care as regards the cleanliness of the wet-bulb and accuracy in reading thermometers to the tenth of a degree, show an unmistakable improvement.

Name of Station. (The Names of the Telegraphic Reporting Stations are in *Italics*.)	Barometer: Difference of Reporting from Inspector's Barometer.	Barometer: Difference of Check from Inspector's Barometer.	Barometer: Difference of Observer's from Inspector's Readings.	Thermometer: Temperature of Water.	Thermometer: Dry Bulb. Correction to reduce to Inspector's Standard.	Thermometer: Dry Bulb. Correction hitherto applied.	Thermometer: Wet Bulb. Correction to reduce to Inspector's Standard.	Thermometer: Wet Bulb. Correction hitherto applied.	Thermometer: Maximum. Correction to reduce to Inspector's Standard.	Thermometer: Maximum. Correction hitherto applied.	Thermometer: Minimum. Correction to reduce to Inspector's Standard.	Thermometer: Minimum. Correction hitherto applied.	Thermometer: Spare. Correction to reduce to Inspector's Standard.	General Condition.
Barrow	−·011	+·002	—	60·1	−0·3	−0·4	−0·3	−0·3	−0·1	−0·1	0·0	−0·1	—	B
Cambridge	+·002	—	—	57·0	−0·4	—	−0·3	—	−0·8	—	0·0	—	—	A
Dungeness	·000	−·017	−·003	64·8	−0·1	—	0·0	—	0·0	—	−0·1	—	—	—
Hurst Point	−·004	−·005	+·002	59·7	−0·1	—	−0·05	—	0·0	—	−0·2	—	—	—
Jersey	−·008	−·001	·000	62·2	−0·3	—	−0·1	—	−0·1	—	−0·05	—	—	A
Loughborough	—	—	—	57·4	−0·45	0·0	−0·4	0·0	+0·5	0·0	+0·2	−0·1	+0·6	A
Oxford	−·028	—	−·001	55·0	−0·05	−0·4*	0·0	−0·4*	−0·1	−0·7*	0·0	−0·2	—	A
Prawle Point	−·001	+·005	·000	59·4	+0·1	—	0·0	—	+0·3	—	0·0	—	—	A
Scilly	+·002	−·001	−·002	56·8	−0·1	—	0·0	—	−0·6	—	+0·1	—	−0·1	A
Shields	−·008	−·001	·000	57·9	−0·1	—	0·0	—	0·0	—	+0·2	—	−0·4	A
Spurn Head	+·004	+·005	+·001	61·6	−0·2	—	−0·3	—	+0·2	—	+0·2	—	—	A
Yarmouth	+·008	−·003	−·002	57·2	+0·2	—	−0·6	—	−0·3	—	−0·1	—	—	A
York	−·013	−·002	−·001	56·9	−0·1	—	−0·1	—	−0·4	—	+0·1	—	—	A
Cronkbourne	·000	—	−·002	60·0	−0·3	—	−0·4	—	0·0	—	0·0	—	+0·1	A
Durham	−·008	—	—	55·0	0·0	0·0	0·0	0·0	0·0	+0·1	+0·7	+0·5	+1·3	A
Eastbourne	+·002	—	·000	60·1	+0·05	0·0	+0·1	0·0	+0·05	−0·1	+0·1	0·0	−0·4	A
Epsom	−·009	—	−·009	53·2	0·0	—	+0·1	—	+0·2	—	0·0	—	—	B
Newton Reigny	−·004	—	·000	55·3	−0·2	−0·3	−0·3	−0·4	−0·1	−0·3	+0·2	0·0	+0·4	A
Plymouth	−·035	—	—	62·3	−0·2	—	−0·1	—	−0·5	—	+0·6	—	0·0	A
Prestwich	−·002	—	+·002	61·1	−0·1	−0·3	0·0	−0·2	−0·1	−0·5	+0·1	−0·2	+0·3	A
Prospect Hill (Douglas)	·000	—	·000	60·0	0·0	0·0	+0·05	0·0	−0·2	−0·3	+0·1	−0·1	−0·6	B
Rugby	−·003	—	−·004	43·2	0·0	0·0	0·0	0·0	+0·25	—	+0·3	—	0·0	C
Seaham	—	—	·000	61·4	−0·5	0·0	−0·4	0·0	+0·4	+0·5	+0·4	+0·5	—	A
Sutton Coldfield	−·006	—	+·001	39·5	−0·1	—	−0·2	−0·1	+0·3	0·0	+0·02	0·0	—	A
York	−·013	−·002	−·001	56·9	−0·1	—	−0·1	—	+0·1	—	+0·7	—	—	B

* Note.—Mr. Stone has retested the thermometers and finds that their previous corrections continue to apply, and that his readings are sensibly correct.

Fishery Barometer Stations.

At the desire of the Secretary, I visited a few Fishery Barometer Stations this year.

On June 10th I visited the harbour-master at *Gorey*, Jersey, in hopes that the thick and rough weather prevailing might enable me to get together an audience of fishermen. In this I was unsuccessful, perhaps on account of the heavy rain. The number of fishing boats now kept at this station is very small, and is rapidly decreasing. The fishery barometer reads low, but contains no air.

I convened a meeting of fishermen on the morning of Saturday, July 20th, at *Port St. Mary*, Isle of Man. The weather was all that could be desired, being thick and wet with an E.S.E. wind. I lectured for about 80 minutes to about 30 men, many of whom, especially the younger, appeared very attentive. Mr. Luattrough, the harbour-master, gave me every assistance. The fishery barometer at this station read 29·720 at 60°·2, while my standard read 29·710 at 60°·5. The fishery barometer is well placed, and the tube is free from air.

On the same day in the afternoon I gave a lecture to about 30 men in the Sailors' Rest at Peel. The men were most attentive; some of the older men held peculiar tenets as to the action of the barometer. The weather was most propitious, enabling me to foretell as probable the strong N.W. breeze which burst over the island the following afternoon. The fishery barometer is well situated on the pier close to the Sailors' Rest, and a few yards from the harbour-master's offices. The instrument (184) read 29·605 at 64°·9. The standard suspended by me within the building at the same elevation read 29·608 (corrected for index error) at 65°·5. The Kew certificate gives ·000 as index error for No. 184.

The case of the cistern of the fishery barometer is much coated with rust externally.

I am of opinion that a short manual or guide to the use of the fishery barometer, containing knowledge brought up to date, expressed in language suitable to the attainments of our fishermen, would form a useful treatise, and be fully appreciated by the majority of those for whom it would be intended.

(Signed) W. Clement Ley.

Report on Inspections of the Self-recording Observatories and Anemograph Stations.

The *Valencia Observatory* was visited from July 29th to August 2nd. The instruments were all inspected and found in good order, the clocks of the barograph and thermograph being cleaned and the light shutters re-adjusted. The anemograph required painting externally, which would be done after inspection, and the direction shaft inside the observatory was loose at some of the joints. It was tightened up, and new pins put in to make it fast. A slight want of repair in the thermograph screen was pointed out to Mr. Cullum.

The mercury in the Beckley gauge was taken out, cleaned, and replaced, with the addition of a quantity of fresh metal to supply a certain amount which had been lost.

The usual comparisons of the thermograph thermometers with the observer's standard, K.O. 682, were made with the following results:—

Dry, No. 399, correction at 60° - - -	−0°·6
Wet, „ 398, „ - - -	−0·5
Max., „ 1003, „ - - -	0·0
Min., „ 2497, „ - - -	−0·2

The *Armagh Observatory* was visited from August 5 to August 7. In the absence of Dr. Dreyer, the director, I was received by the Rev. E. Faris, who was in charge.

The anemograph was found to be much choked and corroded with bad oil, which has been employed for its lubrication; this, however, was removed, and the bearings cleaned. Unfortunately, the new sperm oil purchased by the Meteorological Office for the especial purpose of anemometer oiling had not arrived at the time of my visit, and I was compelled to make use again of the unsatisfactory lubricant in the absence of better.

The Beckley rain-gauge was cleaned, the mercury filtered, and the lifter re-adjusted, all being in satisfactory condition.

Falmouth Observatory, visited August 10 to 15. On examination I found the anemograph, barograph, rain-gauge, and thermograph all in first-rate order, and merely requiring the usual cleaning and oiling, which operations were duly performed.

The thermometers were compared with my standard, and the corrections found to be as follows:—

Dry, No. 383, correction at 63°	-	-	-		° 0·5
Wet, „ 388, „	-	-	-		−0·4
Max., „ 104, „	-	-	-		−0·5
Min., „ 308, „	-	-	-		0·0

The thermometer attached to the standard barometer still requires a correction of −0°·7; this, however, is never applied to its readings, the observers not having received official instruction to do so.

The anemograph at the *Holyhead* pier-head was inspected whilst a gale was blowing on July 24, and therefore was not dismounted.

It was found to be in very good order both inside and outside, all the bearings appearing to be well oiled and quite free. The pins of the connecting shafts were, however, nearly shaken out and had to be driven home tight. I called the attention of Mr. Hugh Williams to them in order that they may be watched in case they should loosen again.

The *Phœnix Park* anemograph, visited July 25, was found working well and in excellent order. The vane bearing, however, has been running in glycerine instead of oil, and this, by absorbing water freely, causes a constant dripping of greasy matter on the curves, which produces a disfigurement.

I suggested the suspension in future of a small zinc cup beneath the bearing in a position to catch the drops.

(Signed) G. M. Whipple.

(M.O. 1951.) Kew Observatory,
October 1889

Dear Sir;

I have the honour to hand you herewith my report and inspection notes regarding the self-registering instruments at the following observatories, Stonyhurst, Glasgow, and Aberdeen, and also the anemograph station at Fleetwood.

(Signed) T. W. Baker.

To R. H. Scott, Esq., F.R.S.

Stonyhurst, visited September 17–18.—Here all the instruments were working satisfactorily.

The thermograph and barograph had their clocks, lenses, and fittings cleaned, after which the various thermometers were compared at 55° by means of Kew Standard No. 682, and the following corrections determined :—

Dry, Standard 619	−0°·1
Wet, „ 382	−0·3
Maximum, M.O. 439	−0·3
Minimum, M.O. 501	+0·1

The anemometer was entirely dismounted, and although found in excellent condition the different parts were cleaned, and fresh oil applied to all the bearings. Afterwards the orientation was tested and found correct.

Mr. Carlisle informed me that the barometer now in use for the control observations is not very satisfactory, the residual corrections varying considerably according as to whether the mercury is rising or falling.

The sunshine recorder is fixed to a stone balustrade about 4 feet above the roof of the magnetic chamber, and is properly adjusted both as regards time and level. A shadow, however, is cast upon it for a few minutes at 2 p.m. during a part of December by the finial ornament fixed on top of a summer house about 30 yards distant south-west, otherwise the exposure is good all the year round.

Glasgow, visited September 20–21.—According to the usual practice the thermograph and barograph clocks were cleaned as well as the other instrumental parts. Cardboard shields were fitted to the thermograph lenses in order to keep reflected light from discolouring the photographic sheets.

The zero lines were changed to the winter position, and the various thermometers compared and found to require the following corrections at 50° :—

Dry, Standard 550	−0°·1
Wet, „ 472	−0·4
Maximum, 58,846	+0·1
Minimum, 63,942	−0·1

The grass minimum (59003) read low by 0°·6, but this was owing to a small quantity of spirit which had become detached from the main column and lodged in the upper portion of the tube. After putting the instrument in order the correction was found to be +0°·1.

The barograph thermometer requires a correction of −0°·8, and the attached thermometer to the standard barometer −0°·5.

As regards the anemometer, the instrument was completely dismounted and cleaned, and fresh oil applied to all its bearings. The clock was also examined and a new line attached.

The orientation was then tested and the sheet containing the result accompanies this report.

New lines were attached to the rain-gauge clock and the usual cleaning performed.

The sunshine recorder is very well placed on the roof of the observatory, and has a good exposure all the year round. It is also properly adjusted for the time and level, but the surface of the glass sphere is somewhat corroded, though it does not appear sufficient to diffuse the light to such an extent as to blurr the solar image on the card.

Aberdeen, September 24–27.—The various instruments at this observatory were in very good order.

My special attention having been called to the stray light which at times was very marked on the thermograph sheets, I dismounted both the dry and wet thermograph tubes and applied several coatings of lamp black mixed with varnish to each tube, after which cardboard shields were fitted to both lenses, and subsequent curves seem to show that the light has been now effectually excluded.

Both the barograph and thermograph clocks as well as the lenses, &c. were cleaned.

The barograph mahogany case did not fit very well, having become slightly warped; this I had put right.

According to instructions the thermometers were tested in pounded ice, and the following corrections were determined at 32° :—

Dry, Standard 397 - - - - -	—0°·1
Wet, „ 395 - - - - -	—0·6
Maximum, 1,002 - - - - -	0·0
Minimum, 5,056 - - - - -	0·0
Attached thermometer (to Standard barometer) No. K.O. 71,061 - - - - -	—0·3
Barograph thermometer (no number) - - - -	—2·0

The external portions of the anemometer were dismounted, and all parts cleaned and fresh oil applied, but the clock and recording apparatus only required oiling. Afterwards the orientation was examined and found satisfactory.

"Squeezes" were taken of both the self-registering and spare rain-gauges.

The Beckley gauge was in excellent order, as well as the clock.

Fleetwood, October 1–2.—On dismounting the anemograph at this station it was found that the oil in the direction bearing had become very thick and hard, but in the velocity bearing it was in a much better condition. The instrument was thoroughly overhauled, and all parts cleaned and fresh oil applied. After remounting it was oriented.

The clock was taken to pieces and cleaned and new lines attached.

(Signed) T. W. Baker.

APPENDIX VIII.

Method of Dealing with Telegraphic Weather Intelligence.

The operations connected with the preparation and issue of the Forecasts and Storm Warnings have not undergone any material change. The Daily Weather Report also has not been altered during the year.

The Office receives, when the telegraphic communications are perfect, fifty-eight* reports every morning, seventeen every afternoon (except

* The Reports from Barrow-in-Furness have ceased.

on Sundays), and twenty-nine each evening, the arrangement of which is explained in the reports for recent years.

At the British and Irish stations the morning observations are taken at 8 a.m. Greenwich time, and most of the telegrams arrive in London at about 9 o'clock, when the Intelligence Department of the Post Office extracts from them the portions required for its wind and weather reports. They are then transmitted to the Meteorological Office by its private wire.

Daily Weather Report.

No important change has been made during the past year in the *form* of the Daily Weather Report, a detailed description of which is given in the Annual Report for 1887. The Report still fills four large quarto pages, and contains on page 1 the whole of the 58 reports from which the maps for the day (given on page 2) are prepared, and the 6 p.m. reports of the previous day, together with the maximum and minimum temperatures of the air, and the rainfall for the previous 24 hours.

On page 2 are two maps, showing (1) for 8 a.m. the distribution of pressure, the prevalent winds, and the sea disturbance, with necessary explanations; (2) the distribution of temperature at 8 a.m., the weather at each station, and the distribution of rainfall during the past 24 hours. Tables are added, giving the means of pressure, temperature, and rainfall as heretofore.

Page 3 contains (1) notes on the "General situation at 8 a.m.," and the "Probable changes in system now prevalent;" and (2) the forecasts drawn up for each district at 11 a.m., relating to the weather likely to be experienced during the 24 hours ending at noon on the day succeeding that of publication, and an explanation of the meaning of the storm signals exhibited on our coasts.

Page 4 contains the observations made at 2 p.m. on the previous day, and "General Remarks on the Weather over Europe during the past 24 hours."

The standing portion of the report (maps, &c.) is printed in blue, while the information for each day is in black.

The subscription for the Report is —

For delivery by hand, where feasible, £2 *per annum;*
Do. by book post £1 „

MS. copies of the observations and remarks can be supplied at the rate of 2*l.* 10*s.* per annum. Arrangements can also be made for the supply of charts drawn from the 8h. a.m. or 6h. p.m. observations, such as appear in the "Times."

Correction and Addition List.

The following additional steps are taken to insure accuracy in the Daily Weather Report. Monthly returns are received, from nearly all of the telegraphic reporting stations, of all the observations which have been transmitted to London by wire. These are used for checking the daily telegrams, for the preparation of the average and other values of the different elements, and also as evidence in the case of legal proceedings. A lithographed sheet is then issued with the Daily Weather Report, containing corrections for all discrepancies which have been discovered, and supplying any observations which have been omitted in the daily reports.

Weekly Weather Report.

The Weekly Weather Report, which has appeared since February 1878, was rearranged at the commencement of 1890, and is now prepared for the conventional week, Sunday to Saturday, in order to bring it into agreement with other weekly publications. This enables it to be published on Thursdays instead of Saturdays. The three daily synchroncus maps which it contains have also been greatly improved, the standing portion (showing the outline of the land and sea) being printed in blue, while the information on them is in black. These maps show (1) for 8 a.m., the temperature, weather, and sea disturbance; and (2) for 8 a.m. and 6 p.m., the distribution of pressure and the winds, over and on the coasts of Europe.

The Summary on the first page contains the average and extreme temperatures, the rainfall values, and the total amount of bright sunshine in each week for twelve districts in Great Britain and Ireland, together with the difference between them and the respective mean values for the corresponding week in previous years. The district values for Accumulated Temperature, Rainfall, and Bright Sunshine are also given, both for the week and for the whole period since the beginning of the year, with their differences from the average values. This information is derived from observations made at 76 stations, the individual values for which are now given on the second page of the Report.

The tables of Accumulated Temperature are designed to give persons engaged in agriculture better means of estimating the manner in which vegetation is affected by temperature than that afforded by the more usual methods of treating the readings of the thermometer. They show for each week, and for the whole period from the beginning of the year, the weekly and progressive values respectively, of the combined amount and duration of the excess or defect of the air temperature, above or below a suitably fixed standard or *base temperature*. The base adopted is 42° F., as being nearly equivalent to 6° Cent. which has been considered by continental writers on these subjects to be the critical value, the temperature above which is mainly effectual in starting and maintaining the growth, and in completing the ripening of agricultural crops in a European climate. This base is also convenient as being 10° F. above the freezing point.

Accumulated Temperature is expressed in Day-degrees; a Day degree signifying 1° F. of excess or defect of temperature above or below 42° F. continued for 24 hours, or any other number of degrees for an inversely proportional number of hours.

An explanation of these rules will be found in the last Annual Report, and full details as to the facts on which the rules are founded are published in Appendix II. to the Quarterly Weather Report for 1878.

The temperature means, derived from the daily maxima and minima, are corrected so as to agree as closely as possible with the true mean daily value, and, the average values for the corresponding period in former years are:—

For Temperature	- -	20 years 1861–80
„ Rainfall	- -	20 „ 1866–85

The values for temperature, accumulated heat, rainfall, and sunshine for *each station** are given on the second page of each Report.

The Synchronous Charts referred to on page 17, with the daily Remarks thereon, occupy the third to sixth pages.

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* The sunshine values are furnished for only a limited number of carefully selected stations. See p. 103.

In addition to the reports from the Telegraphic Reporting Stations, and the returns from the self-recording Observatories, weekly returns from 43 volunteer observers are used, the names of the stations and observers being as under :—

Names of Stations.	Names of Authorities.
Alnwick Castle - - -	Lieut.-Col. F. Holland, for the Duke of Northumberland, K.G.
Arlington (N. Devon) - -	J. Carter, for Lady Chichester.
Buwtry (Hesley Hall) - -	B. I. Whitaker, J.P., F.R. Met. Soc.
Blackpool - - - ℳ	J. Wolstenholme.
Braemar - - - 𝒮	J. A. Aitken, J.P.
Brookeborough - - -	Mr. Ferguson, for Sir Victor Brooke, Bt., F.L.S.
Cheadle - - - ℳ	J. C. Philips.
Churchstoke - - - ℳ	P. Wright, F.C.S., F.R. Met. Soc.
Cirencester - - - -	The Royal Agricultural College.
Cullompton - - - ℳ	T. Turner, J.P., F.R. Met. Soc.
Douglas (Isle of Man) - -	A. W. Moore, M.A., J.P.
Dublin - - - -	J. W. Moore, M.D., F.R. Met. Soc.
Durham Observatory - -	H. J. Carpenter.
Edgeworthstown (Currygrane) -	J. M. Wilson, J.P.
Fort Augustus - - 𝒮	Rev. E. G. Cody.
Foynes - - - -	W. Ward, for Lord Monteagle, K.P.
Geldeston - - - -	E. T. Dowson, F.R. Met. Soc.
Glen Carron - - 𝒮	D. D. Munro.
Glenlee - - - 𝒮	G. Maxwell and W. Melville.
Hastings (St. Leonard's) - -	H. Colborne, M.R.C.S.
Hereford - - - ℳ	T. A. Chapman, M.D.
Hillington - - - ℳ	Rev. H. E. B. Ffolkes, M.A., F.R. Met. Soc.
Ingatestone - - - -	L. J. Petre, F.R. Met. Soc.
Kilkenny - - - -	H. Carlton, for the Marquis of Ormonde, K.P.
Killarney - - - -	The Ven. Archdeacon Wynne, F.R. Met. Soc.
Lairg - - - 𝒮	J. Young, Ground Officer.
Laudale (Loch Sunart) - -	A. Fletcher, for T. H. G. Newton, M.A., F.R. Met. Soc.
Llandovery - - - -	J. Watkins, F.R. Met. Soc.
Llandudno - - - ℳ	J. Nicol, M.D., F.R. Met. Soc.
Londonderry - - - -	J. Conroy, F.R. Met. Soc.
Marchmont - - - 𝒮	P. Loney.
Markree Castle (Co. Sligo) - -	A. Marth, F.R.A.S., for Colonel Cooper, F.R.A.S.
Newton Reigny (Penrith) - -	T. G. Benn, F.R. Met. Soc.
Ochtertyre - - - 𝒮	G. Croucher.
Oswaldkirk (sunshine only) - -	R. Thompson.
Plymouth - - - -	J. Merrifield, LL.D., F.R.A.S.
Prestwich (Manchester) - -	T. R. H. Clunn, M.D., F.R. Met. Soc.
Rothamsted - - -	Rainfall by Sir J. B. Lawes, Bart., LL.D., F.R.S., and J. H. Gilbert, Ph.D., F.R.S.; temperature by T. Wilson, F.R. Met. Soc.
Scarborough - - - ℳ	W. Robinson.
Southampton - - - -	J. T. Cook, R.E., Ordnance Survey Office.
Stowell - - - ℳ	Rev. H. J. Poole, F.R. Met. Soc.
Strathfield Turgiss - - ℳ	Rev. C. H. Griffith.
Thurcaston (sunshine only) - -	Rev. T. A. Preston, F.R. Met. Soc.
Waterford (Brook Lodge) - -	C. Percival Bolton, J.P.
Westgate-on-Sea (sunshine only) -	J. Norman Lockyer, F.R.S.
Worksop (sunshine only) - -	H. Mellish, J.P., F.R. Met. Soc.

The returns marked "ℳ" are supplied through the Royal Meteorological Society, those marked "𝒮" are through the Scottish Meteorological Society.

The report is now prepared on Tuesday in every week, and is ready for sale on Thursday afternoon, but the summary on its first page is sent to the "Times," "Daily News," and several other papers on Tuesday evening.

Appendices.

Appendices, four in number, have appeared, similar to those for last year, with a Monthly Summary.

Monthly Summary.

The publication of the *Monthly Weather Report* has ceased, but a Supplement to the Weekly Report is issued in the form of a *Monthly Summary*, giving for each calendar month the mean and principal values for the different elements, Pressure, Temperature, Rainfall, and Sunshine, with four maps, and some brief notes as to the chief features exhibited. These have all been issued to date.

Issue of Forecasts.

Remarks on the actual state of the weather, and forecasts ***for not more than one day in advance***, are prepared at the Meteorological Office as under :—

On Week Days.

(1.) At 11 a.m. (from the morning reports), for the 24 hours ending at Noon on the day following the date of issue. These are intended especially for the early editions of the evening papers, for the clubs, and for exhibition at certain selected stations. See page 9.

(2.) At 3.30 p.m. (from the morning and afternoon reports), for the day following that of issue. This set of forecasts is not intended for publication in newspapers, but a copy is exhibited regularly at the door of the Meteorological Office.

(3.) At 8.30 p.m. (from the 8 a.m., 2 p.m., and 6 p.m. reports), for the day following that of issue. These are now supplied gratis to any newspaper or news agency which may apply for them, and send for them regularly. A very large number of the most important papers and news agencies avail themselves of this advantage.

The forecasts are made for the following districts :—

0. Scotland, North.
1. Scotland, East.
2. England, N.E.
3. England, East.
4. Midland Counties.
5. England, South.
6. Scotland, West (with Isle of Man).
7. England, N.W. (with North Wales).
8. England, S.W. (with South Wales).
9. Ireland, North.
10. Ireland, South.

The remarks and forecasts are posted at the doors of the Meteorological Office, 63, Victoria Street, S.W., on week days,* for the inspection of the public. Copies, or extracts from them, are communicated under the conditions stated below, but no information which is not substantially included in them can be supplied.

Arrangements have lately been made for exhibiting on the front of the Office, a series of boards showing in large type the state of the wind, weather, and sea disturbance at six stations, situated on our S.E., S., and S.W. coasts. The stations selected are Yarmouth, Dungeness, The Needles, Scilly, Holyhead, and Valencia Island, and the observations posted up are those for 8 a.m. and 2 p.m. daily, except on Sundays.* The information can be easily read from the road.

FORECASTS FOR SUBSCRIBERS.—Any person can be supplied with a copy of the 11 a.m. Forecasts, once on each week day,* on payment of a subscription of ten shillings per annum, or 2*s.* 6*d.* per official quarter, *or any part thereof, in addition to the cost of transmission*; the charges will therefore be, by *letter* post, 9*s.*, by *book* post, 5*s.* 9*d.* per quarter.

The forecasts for any of the districts and for any of the hours mentioned on p. 90 can be forwarded by telegraph daily, on payment of 3*d.* per day for any definite period, in addition to the cost of telegraphy.

FORECASTS FOR CLUBS.—These are drawn up at 11 a.m., for all the districts, and are supplied to Clubs, for a subscription of ten shillings per annum. They are delivered free, by hand, to Clubs situated in or near Pall Mall. Special arrangements can be made for delivery at a greater distance by hand or by post.

FORECASTS FOR HAY AND CORN HARVESTS, OR FOR PUBLIC USE.—Special facilities are offered for the transmission of Forecasts for these purposes, a nominal fee of 2*s.* 6*d.* being charged for a quarter or any part thereof, in addition to the cost of the telegrams.

EXHIBITION OF TELEGRAPHIC FORECASTS AT LOCAL POST OFFICES.—The Post Office has sanctioned the exhibition of Forecasts at Local Post Offices, provided space is available, if the persons to whom they are addressed desire them to be so exhibited instead of being delivered.

Unless otherwise arranged, all forecasts transmitted by post are sent by book post, not as letters.

INQUIRIES as to the WEATHER.

INQUIRIES PERSONALLY OR BY MESSENGER.—Any person applying at the Meteorological Office between 11 a.m. and 8 p.m. on week days, and between 7 p.m. and 8 p.m. on Sundays, can be supplied, in writing, with the latest information in the possession of the Office and with the latest forecast issued for any specified district, on payment of one shilling for each inquiry.

INQUIRIES BY LETTER.—Application may be made by letter, enclosing thirteen pence in stamps if the reply is to be *by post*, and one shilling in stamps, in addition to the cost of the reply (consisting of ten words, exclusive of the address) if the reply is to be *by telegraph*.

INQUIRIES BY TELEGRAPH.—Any person may obtain *by telegraph* from the Meteorological Office the latest information as to the weather

* Good Friday and Christmas Day are reckoned as Sundays.

in any district of the United Kingdom by payment of a fee of 1*s.* in addition to the cost of a telegram and reply to any post office. The telegram containing the inquiry must be addressed as follows:

WEATHER,
LONDON.

The payment for the reply should be for at least ten words in addition to the address.

Application may also be made for similar information to be sent either *by telegraph* or *post* on some future specified day.

CHECKING of FORECASTS.

In order to test the accuracy of the forecasts they are compared carefully with the weather reported in the various districts on the days to which they referred, and the results of the checking for 8.30 p.m. are given in this Report (page 10).

In carrying out this comparison the portions of the forecasts which referred to wind have been carefully separated from those relating to weather. The detailed results of the comparison will be found in Appendix X., page 94.

CHECKING of STORM WARNINGS.

The testing of the warnings is still conducted in the manner indicated in earlier reports.

In order to render the information in the possession of the Office as to the weather experienced on our coasts still more complete, the Council have, as in preceding years, made application to the various Lighthouse Boards, and have obtained from them the original log-books from some of the most exposed lightships and lighthouses. They would here express their cordial thanks for the co-operation so readily granted to them by these Boards.

The result of the checking for 1889 will be found on page 13.

In the course of the ensuing year improvements are to be made both in the issue and checking of these storm warnings.

APPENDIX IX.

CORRESPONDENCE with CHIEF SIGNAL OFFICE, WASHINGTON, as to FORECASTS.

(M.O. 825.)

Signal Office,
War Department, Washington City,
April 26, 1889.

DEAR SIR,

I SHALL be very much gratified if you will kindly furnish me with certain information concerning the methods, form, and extent of weather forecasts made by the weather service under your direction. Information upon the following points is especially desired:—

First. At what hour of the day are the observations made on which weather forecasts are based.

Second. At what hour of the day are the predictions themselv issued.

Third. Are these forecasts distributed generally by telegraph, or by what means and to what extent do they reach the general public.

Fourth. Are the weather forecasts generally displayed throughout your country, or is their use limited largely to the central station.

Fifth. How long a period in advance is covered by these forecasts, and does such period count from the hour of observation or from the hour of making the forecast.

Sixth. Are daily weather maps or bulletins issued for current use, and, if so, how long after the hour of observation is it before they reach the general public.

I should be very much gratified also if you would give the benefit of your advice, based on your experience in forecasts, as to whether you believe that forecasts general in their nature best meet meteorological needs, or whether they should be sharply defined as to time, locality, and phenomena.

I should be also pleased to know whether you find it to be true or not that the greater part of the rain which falls comes rather in patches and as local showers than as general rains which cover the entire country.

Appreciating the courtesy you extend to me by giving me information on these points, and asking the great favour of an early reply,

I am, &c.

(Signed) A. W. GREELY,
Brigadier General and
Chief Signal Officer.

Mr. R. H. Scott,
Secretary of the Meteorological Committee,
116, Victoria Street, London, S.W., England.

(P.C. 1113.) Meteorological Office,
June 1, 1889.

DEAR SIR,

IN reply to your letter of April 26, I am instructed by the Council to supply you with the following answers to the queries contained therein.

First.—The observations are made at 8h. a.m., 2h. p.m., and 6h. p.m.

NOTE.—The Postal Telegraphic offices are, generally speaking, not opened before 8h. a.m., and are closed at 8h. p.m.

Second.—Forecasts are prepared three times daily on week days, viz., at 11h. a.m., 3h. 30m. p.m., and 8h. 30m. p.m. Only those prepared at 11h. a.m. and 8h. 30m. p.m. are issued to the public, except in the summer during the harvest. (*See* answer to questions 3 and 4.)

On Sundays the only forecasts drawn out are those at 8h. 30m. p.m. for publication on Monday mornings, the Sunday morning observations are used as data for the issue of storm warnings only. The afternoon service is suspended on Sundays.

Third and *Fourth.*—The 8.30 p.m. forecasts are supplied at the office gratuitously to the newspapers, either directly or through the press agencies, and appear in the leading newspapers all over the kingdom on the following morning. They are not issued otherwise by the office.

The 11h. a.m. forecasts are printed at the office on separate fly-sheets, and supplied to subscribers, almost exclusively resident in London, at a yearly charge of 10*s.* They are also distributed gratuitously for exhibition to the public at various places in London,

including the Meteorological Office, the Mansion House, and many of the shops of leading opticians. These forecasts are also reproduced in the lithographed Daily Weather Report, and appear in some of the evening newspapers in London, to which they are supplied gratuitously.

The 3h. 30m. p.m. forecasts are exhibited at the Meteorological Office, and during the Hay Harvest operations are sent by telegraph at the expense of the Office to about 30 selected stations where they are exhibited to the public.

A few persons are also supplied with these forecasts during the harvest on the payment of a nominal fee and the cost of telegraphy.

Fifth.—The forecasts cover a period of about 24 hours. Those prepared at 11h. a.m. cover the period till noon next day. Those prepared at 3h. 30m. and 8h. 30m. p.m. refer to the next civil day.

Sixth.—The lithographed Daily Weather Report is issued to the extent of over 480 copies, of these 60 are supplied gratuitously for exhibition at seaports. About 150 are forwarded also gratuitously to scientific institutions, &c. at home and abroad, and nearly 200 are supplied to private subscribers.

The forecasts are sub-divided as to the 11 districts into which the United Kingdom has been divided, on agricultural considerations. These are shown in the key map published with the Weekly Weather Report.

In the opinion of the Council it is not possible to define forecasts sharply either as to time, locality, or phenomena.

No discussion of the rainfall has as yet been carried out with a view to showing the extent to which it is general in its distribution or partial. This would probably be found to be in some measure dependent on the season of the year, as well as on the particular atmospheric conditions under which the rain fell.

In all cases the existence of a line of hills transverse to the direction of the wind, renders the fall locally more or less partial.

I am, &c.

(Signed) ROBERT H. SCOTT,
Secretary.

P.S.—I enclose copies of Circulars 27 and 27*a*, which explain the supply of weather information to the public and the press.

APPENDIX X.

REPORT ON THE COMPARISON OF THE FORECASTS ISSUED AT 8h. 30m. p.m. WITH THE WEATHER SUBSEQUENTLY EXPERIENCED, for the 12 Months, April 1889 to March 1890. The results are for the United Kingdom as a whole.

The letters used have the following signification :—

a = complete success.	**c** = partial failure.
b = partial (more than half) success.	**d** = total failure.

The checking has been conducted on the same system as that employed in previous years, *i.e.*, each forecast has been considered under the separate headings of "Wind" and "Weather," but the results of the 8.30 p.m. Forecasts only are here published.

The first column gives the percentage of success in "Wind," the second in "Weather," and the third the average of the two.

The Summary for the whole year is given at page 10.

Months.		Per-centages. Wind.	Weather.	Average.	a + b.	Months.		Per-centages. Wind.	Weather.	Average.	a + b.
April	a	46	50	48	80	October	a	36	54	45	78
	b	36	28	32			b	40	26	33	
	c	13	11	12			c	16	13	15	
	d	5	11	8			d	8	7	7	
May	a	59	50	55	83	November	a	55	39	47	81
	b	27	30	28			b	28	45	37	
	c	10	12	11			c	11	7	9	
	d	4	8	6			d	6	9	7	
June	a	59	57	58	85	December	a	41	41	41	73
	b	31	23	27			b	30	35	32	
	c	9	10	10			c	17	14	15	
	d	1	10	5			d	12	12	12	
July	a	55	51	53	81	January	a	41	48	45	78
	b	29	27	28			b	32	34	33	
	c	12	16	14			c	20	10	15	
	d	4	6	5			d	7	8	7	
August	a	49	52	51	85	February	a	60	53	57	84
	b	34	35	34			b	24	30	27	
	c	9	8	9			c	10	8	9	
	d	8	5	6			d	6	9	7	
September	a	52	51	52	82	March	a	33	46	40	75
	b	30	31	30			b	36	35	35	
	c	11	9	10			c	23	8	16	
	d	7	9	8			d	8	11	9	

APPENDIX XI.

Telegraphic Weather Intelligence.

The following stations are supplied with telegraphic information of storms, free of expense, and signal "cones" have been furnished to most of them, all further expenses attendant on the maintenance and repair of the apparatus being borne locally. The stations are situated, 88 in England and Wales, 44 in Scotland, 15 in Ireland, 3 in the Isle of Man, and 3 in the Channel Islands.

NORTH.	WEST.	SOUTH.	EAST.
SCOTLAND, N.E.	IRELAND, S.W.	ENGLAND, S.W.	ENGLAND, E.
Lerwick.	New Ross.	Scilly.	Harwich.
Scalloway.	Dunmore East.	St. Just.	Ipswich.
Dunrossness.	Dungarvan.	St. Sennen.	Southwold.
Stromness.	Youghal.	Penzance.	Yarmouth.
Kirkwall.	Queenstown.	Falmouth.	Cromer.
Holborn Head.	Passage.	Pendennis.	Sheringham.
Wick.	Cork.	Mevagissey.	Lynn.
Avoch.	Kinsale.	Plymouth.	Sutton Bridge.
Inverness.	Tralee.	Devonport.	
Nairn.	Limerick.	Teignmouth.	
Burghead.	Galway.	Exmouth.	
Lossiemouth.			
Buckie.	IRISH SEA.		
Port Knockie.	Belfast.		
Cullen.	Donaghadee.		
Portsoy.	Howth.		
Banff.	Kingstown.		
Fraserburgh.	Ramsey (I. of M.).	ENGLAND, S.	
Peterhead.	Douglas ,,	Guernsey.	
Aberdeen.	Castletown ,,	St. Heliers (Jersey).	ENGLAND, N.E.
	Silloth.	Gorey (Jersey).	Boston.
	Maryport.	Weymouth.	Cleethorpe.
	Workington.	Poole.	Grimsby.
	Whitehaven.	Cowes.	Goole.
	Barrow.	Ryde.	Hull.
SCOTLAND, E.	Morecambe.	Portsmouth.	Bridlington Quay
Stonehaven.	Fleetwood.	Littlehampton.	Filey.
Montrose.	Blackpool.	Brighton.	Whitby.
Broughty Ferry.	Lytham.	Newhaven.	Redcar.
Dundee.	Southport.		Middlesborough.
St. Andrews.	Liverpool.		Sunderland.
Anstruther.	Runcorn.		South Shields.
Pittenweem.	Connah's Quay.		Tynemouth.
Burntisland.	Penmaenmawr.		Berwick - on - Tweed.
Grangemouth.	Port Penrhyn.		
Bo'ness.	Port Dinorwic.		
Granton.	Carnarvon.	ENGLAND, S.E.	
Newhaven.	Holyhead.	Hastings.	
Leith.		Rye.	
Fisherrow.	ST. GEORGE'S CHANNEL.	Sandgate.	
Dunbar.		Folkestone.	
Cockburnspath.	Aberystwith.	Dover.	
Eyemouth.	Milford.	Margate.	
		Faversham.	
	BRISTOL CHANNEL.	Sheerness.	
	Pembrey.	Chatham.	
	Llanelly.		
	Swansea.		
SCOTLAND, N.W.	Briton Ferry.		
Port of Ness (Island of Lewis).	Porthcawl.		
	Penarth.		
	Cardiff.		
	Newport.		
	Weston-super-Mare.		
	Burnham.		
	Ilfracombe.		
SCOTLAND, W.	Barnstaple.		
Glasgow.	Appledore.		
Greenock.	Boscastle.		
Rothesay.	Port Isaac.		
Campbelton.	Newquay.		
Girvan.	Hayle.		
Ballantrae.	St. Ives.		

APPENDIX XII.

CORRESPONDENCE with the BOARD OF TRADE as to the WASHINGTON MARITIME CONFERENCE.

(M.O. 1977.) Board of Trade, (Marine Department),
London, S.W.
November 11, 1889.

SIGNALS.

SIR,

I AM directed by the Board of Trade to request that you will be good enough to lay the following circumstances before the Council of the Meteorological Office for their consideration.

A Maritime Conference (to which Her Majesty's Government have sent delegates) is now sitting at Washington. It was at first arranged that the British Delegates should not proceed beyond a discussion of (1) the Regulations for preventing Collisions at Sea; and (2) the draft to which vessels should be loaded.

Her Majesty's Government have, however, now decided to join in the discussion of other matters, among which the following are included:—

(*a.*) The transmission of warnings;

(*b.*) The uniformity of signals employed.

Under these circumstances, Lord Salisbury and Sir Michael Hicks-Beach are desirous of sending to Washington at once an additional delegate competent to take part in the discussion on these points; and I am to request that you will ask the Council of the Meteorological Office to favour the Board of Trade with their observations in the matter, and to suggest the name of a gentleman they think suitable for the duty in question.

I am, &c.

The Secretary, (Signed) HENRY G. CALCRAFT.
Meteorological Office,
116, Victoria Street, S.W.

(P.C. 2148.) Meteorological Office,
November 13, 1889.

SIR,

I HAVE to acknowledge the receipt of your letter of the 11th instant, addressed to the Secretary of the Meteorological Council, relative to a proposal to send to the Maritime Conference now sitting at Washington a delegate qualified to take part in a discussion on storm warnings, which subject is among those to be brought before the conference.

Understanding it to be important that no time should be lost in dealing with this matter, I think it better to inform you at once of the conclusions I have come to, after discussion with the Secretary to the Council, rather than wait to bring it before the full Council, which would necessarily involve a delay of some days. I feel satisfied, however, that the opinions I shall express would be confirmed by the Council.

I cannot think that any practical advantage would be derived from sending a delegate to Washington for the purpose in question. The subject of storm warnings and of forecasting weather, on which the issue of such warnings depends, has been constantly before the Meteorological Office from its first formation, and the Council has been in frequent and intimate communication with the Meteorological Office at Washington as well as with the corresponding departments of the chief States of Europe on the subject, and it regularly interchanges telegraphic infor-

mation with these last for the purpose of weather forecasting. For more than two years the Council received from Washington daily telegrams designed to convey from the other side of the Atlantic information obtained there, and considered to be likely to be useful in the forecasting of weather in the British Isles. A very prolonged and patient discussion of the data thus procured has satisfied the Council, and I may add all the staff employed in the preparation of forecasts, which is composed of very intelligent persons, having very prolonged experience in this branch of duty, that no advantage whatever could at present be derived from communications received from the coasts of America. The Council have therefore for nearly a year ceased to participate in this special telegraphic service, and there seems to be no prospect of the character of the available information being so modified as to justify its renewal.

Doubtless great advantage may be obtained by improving and extending the transmission of information along the coasts of the continent of America from and to suitable stations, and there is every reason to think that the Meteorological Offices of the United States and the Dominion of Canada fully appreciate this, and act in concert in giving effect to it.

But the preparation of weather forecasts, and the issue of warnings as to expected storms, must in the very nature of the subject be dealt with locally, and it is very questionable whether any useful purpose would be gained by the adoption of uniformity of methods, otherwise than so far as the general progress of scientific knowledge indicates the direction of possible improvement, and this it is hardly necessary to say is more likely to be secured by looking favourably on independent working rather than the reverse.

Even in such a matter as that of weather signals, it also seems doubtful whether the attempt to introduce uniformity would be successful or useful. Such signals are virtually made for the use of the shipping or fishing vessels in the harbours or proposing to leave them, and so long as their significance is clearly understood by the local population, they may be held to have performed the functions expected of them.

Finally. I may observe that there is no one whom the Council is likely to name, should the deputation of a delegate be resolved on, except their Secretary, Mr. R. H. Scott, who no doubt possesses all the necessary qualifications. But such a mission would be entirely outside the duties of his office, and he could hardly be expected to undertake it without special remuneration.

I am, &c.
(Signed) R. STRACHEY,
Chairman of the Meteorological Council.

The Assistant Secretary,
Marine Department, Board of Trade.

APPENDIX XIII.

CORRESPONDENCE with the BOARD OF TRADE as to a METEOROLOGICAL STATION at BERMUDA.

METEOROLOGY.

(M.O. 1222.) Board of Trade (Marine Department,)
SIR, London, S.W., July 9, 1889.

I AM directed by the Board of Trade to transmit to you, to be laid before the Council of the Meteorological Office, a letter with inclosures, which they have received from the Colonial Office on the subject of a proposal which has been made to establish a meteorological station at Bermuda, and I am to state that, before replying to Lord Knutsford, the Board would be glad to be favoured with the views of your Council on the subject, both as regards the expediency of establishing such a station and the probable cost of so doing.

I am to request that the inclosures may be returned with your reply.

I am, &c.
(Signed) THOMAS GRAY.

The Secretary,
Meteorological Office,
116, Victoria Street, Westminster, S.W.

SIR, Downing Street, July 3, 1889.

I AM directed by Lord Knutsford to transmit to you, to be laid before the Board of Trade, a copy of a despatch from the Governor-General of Canada, and of a letter from the High Commissioner for Canada in London, recommending the establishment of a meteorological station at Bermuda.

Lord Knutsford would be glad to learn the views of the Board of Trade on this proposal, and also to be furnished with any information which may be in the possession of the Board of Trade as to the probable cost of establishing and maintaining such an observatory.

I am, &c.
(Signed) R. H. MEADE.

The Secretary to the
Board of Trade.

Sir C. TUPPER to the COLONIAL OFFICE.

9, Victoria Chambers, Westminster, S.W.,
SIR, June 24, 1889.

I HAVE the honour to transmit to you herewith, a copy of an order of the Privy Council of Canada, dated the 27th May 1889, with reference to the proposed telegraphic communication between Bermuda and Halifax.

I venture to think that the proposal made by the Minister of Marine and Fisheries that a meteorological station should be established at Bermuda, and that observations should be telegraphed regularly therefrom to the head office in Toronto, worthy of the consideration of Her Majesty's Government. I beg, therefore, that you will be so good as to move Lord Knutsford to bring the matter to the notice of the proper authorities, and trust that the suggestion will have the benefit of his Lordship's powerful support.

I am, &c.
(Signed) CHARLES TUPPER.

The Under Secretary of State,
Colonial Office.

LORD STANLEY OF PRESTON to LORD KNUTSFORD.

Canada, New Richmond P.Q.,
June 4, 1889.

MY LORD,

THE Director of the Meteorological Service at Toronto having drawn the attention of the Dominion Government to the fact that the Bermuda Islands will shortly be in telegraphic communication with Halifax, and that great benefit would accrue to the service by the establishment of a meteorological station at Bermuda, I have the honour to transmit to your Lordship a copy of an approved minute of the Privy Council, embodying a report of my Minister of Marine and Fisheries upon the subject.

I have, &c.
(Signed) STANLEY OF PRESTON.

The Right Hon. Lord Knutsford,
&c. &c. &c.

CERTIFIED COPY of a REPORT of a COMMITTEE of the Honourable the PRIVY COUNCIL, approved by his Excellency the GOVERNOR GENERAL in Council on the 27th May 1889.

ON a report dated 20th May 1889 from the Minister of Marine and Fisheries stating that the Director of the Meteorological Service at Toronto has drawn attention to the fact that the Bermuda Islands will shortly be in telegraphic communication with Halifax, and that great benefit would accrue to the service by having a meteorological station at Bermuda, and observations telegraphed therefrom twice a day to the head office in Toronto.

The Minister states that it appears that there is a class of storms which frequently do a large amount of damage in the Maritime Provinces and the Gulf of St. Lawrence, the occurrence of which the Meteorological Service are unable at present to foresee for any considerable time before they strike the shores of Canada, and the Director is of opinion that if he had regular returns from Bermuda of observations, taken at the same time as those on the Continent, he would probably be able, as a rule, to locate the position of these storms with sufficient accuracy to give at least 24 hours warning of their approach to the coast, a warning which would be the means of saving much loss of life and destruction of property.

The Minister is of opinion that the establishment of a station at Bermuda would be of benefit not only to Canada, but that it would also be attended with much advantage to Her Majesty's ships of war stationed at Halifax, and he recommends that the matter be brought under the consideration of Her Majesty's Government, and inquiry be made as to whether they would not assume the cost of establishing a station at Bermuda and transmitting the telegraph messages required to the head office of the Dominion Meteorological Service at Toronto, it being understood that the cost of issuing the necessary warning to shipping on the receipt of such messages is to be defrayed by the Government of Canada.

The Committee concurring in the above recommendation of the Minister of Marine and Fisheries advise that your Excellency be moved to forward a copy of this minute to the Right Honourable the Secretary of State for the Colonies.

All which is respectfully submitted for your Excellency's approval.

(Signed) JOHN MCGEE, Clerk,
Privy Council.

(P.C. 1482.)

SIR, Meteorological Office, July 31, 1889.

YOUR letter of the 9th instant relative to the proposed establishment of a meteorological station at Bermuda having been considered by the Meteorological Council, I am directed to convey to you the following expression of the opinions they have formed on the questions submitted to them.

The Council can have no doubt that advantage should be taken of the establishment of telegraphic communication with Bermuda to obtain regular meteorological reports from that island, to be utilised in improving the forecasts of weather to be expected on the coasts of the North Atlantic. They consequently do not hesitate to support the proposal of the Government of the Dominion of Canada to form a meteorological station at Bermuda, from which regular reports should be transmitted to Halifax and Toronto.

The Council are not in possession of precise information as to the system of forecasting adopted by the Central Canadian Meteorological Office at Toronto, but it is presumed that information is obtained from the United States Bureau at Washington as to the advance of any atmospheric disturbances from the south, likely to have influence on the weather in Canada. It is necessary to remark that, for any reliable forecast of changes of weather likely to result in Canada from disturbances in the neighbourhood of Bermuda, it would be necessary to consider the effect of changes that might occur in the intervening region, and the atmospheric conditions along the coasts of the United States. These are systematically taken cognizance of at the Office at Washington, which would unquestionably desire to be furnished with any meteorological reports sent from Bermuda. The well-known liberality of the Washington Office leads the Council to expect that information of the nature now in question, which that Office might obtain, would be readily communicated to Toronto, and, combined with this, the reports from Bermuda might reasonably be expected to supply very valuable data for forecasting the weather on the coasts of Canada, the importance of accuracy in which to the ships of Her Majesty's Navy, as well as the Mercantile Marine, is indisputable.

With reference to the cost of establishing and maintaining such a meteorological station, I am to state the usual equipment of instruments for a telegraphic reporting station is about 12*l.* No special building is needed, and suitable places for the instruments could, no doubt, readily be found in or near the telegraph office. Further, as the requisite observations would only occupy a few minutes two or three times a day, it would probably be possible to secure the services of one or other of the telegraph signallers by a small payment, such as is usual at similar stations in this country, which would not exceed 15*l.* to 20*l.* yearly.

I am, &c.

(Signed) ROBERT H. SCOTT,
Secretary.

The Assistant Secretary,
Marine Department, Board of Trade.

APPENDIX XIV.

Fishery Barometers.

List of Places supplied with Fishery Barometers.

Shetland Isles.—*Balta Sound, *Uya Sound, *Nesting, *Lerwick, *Sandsair, *Scalloway, *Symbister.

Orkney Isles.—Westray, *Burra, *Kirkwall.

Scotland, east coast.—Freswick, Auchengill, *Keiss, *Staxigoe, *Wick, *Sarclet, *Lybster, *Dunbeath, *Portmahomack, *Cromarty, *Avoch, *Nairn, *Burghead, *Portessie, *Port Knockie, *Portsoy, *Whitehills, *Gardenstown, *Rosehearty, *Pitullie, *Inverallochy, *Pointlaw, *Findon, *Portlethen, *Skateraw, *Stonehaven, *Arbroath, *Broughty Ferry, *St. Andrews, *Crail, *Cellardyke, *St. Monance, *Burntisland, *Newhaven.

England, east coast.—*Berwick, *North Shields, *South Shields, *Sunderland, *West Hartlepool, *Staithes, *Scarborough, *Filey, *Flamborough, *Bridlington Quay, Withernsea, Hull, *Lynn (2), *Wells, *Gorleston, *Harwich, *Brightlingsea, *Margate, *Deal, *Kingsdown, *Dover.

England, south coast.—Bognor, Ryde, East Cowes, Bembridge, Brixton, Atherfield, Ventnor (2), *Gorey (Jersey), Haslar Hospital, Poole, Weymouth, Portland, Budleigh Salterton, Exmouth, Cawsand, Mevagissey, Gorranhaven, Devoran, Portscath, Penryn, Durgan, Porthallow, Falmouth, Coverack, Newlyn, Mousehole.

England, south-west coast.—St. Ives, Hayle, Padstow, Port Isaac, Boscastle, Highbridge, Weston-super-Mare.

Wales.—Briton Ferry, Swansea,* Angle, *Milford, Nevin, Carnarvon.

England, north-west coast.—*Fleetwood, *Morecambe, *Maryport.

Isle of Man.—*Douglas, *Port St. Mary, *Peel.

Scotland, south-west coast.—*Port Patrick, *Stranraer.

Ireland, east coast.—*Cushendall, *Belfast, *Bangor (Co. Down), *Groomsport, *Donaghadee, *Ardglass, *Carlingford, *Greenore, *Dundalk, *Malahide, *Howth, *Kingstown (2), *Bray, *Wicklow.

Ireland, south coast.—Dunmore East, Dungarvan, Crosshaven, Kinsale, Union Hall, Castletownsend, Baltimore, Schull, Crookhaven.

Ireland, west coast.—*Valencia, Dingle, Tralee, Tarbert, Kilcredane, Kilronan, Spiddal, *Elly Bay, *Ballyglass, *Ballycastle (Co. Mayo), *Donegal,*Tribane, *Killybegs, *Teelin, *Portnoo, *Burton Port, *Kincaslagh, *Bunbeg.

Ireland, north coast.—*Dunfanaghy, *Rathmullen, *Buncrana, *Moville, Greencastle, *Portrush, *Portstewart.

Scotland, west coast.—*Tarbert (Loch Fyne), *Campbeltown, *Carradale, *Portree (Isle of Skye), *Plockton, East Mey, *Stroma.

Hebrides.—*Stornoway, Portnaguiran, *Obb, Valtos, Carloway, *Ness.

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* Inspected.

SUMMARY of STATIONS supplied with INSTRUMENTS.

England and Wales - - - - -	66
Scotland and Isle of Man - - - -	62
Ireland - - - - - -	49
	177

APPENDIX XV.

LIST of STATIONS from which CONTINUOUS RECORDS of BRIGHT SUNSHINE have been received.

Station.	Observer.
Aberdeen Observatory - -	Prof. C. Niven, M.A., F.R.S.
Armagh Observatory - - -	J. L. E. Dreyer, Ph.D., F.R.A.S.
Blackpool - - - -	J. Wolstenholme.
Cambridge - - - -	H. Todd.
Churchstoke - - - -	P. Wright, F.C.S., F.R. Met. Soc.
Cirencester - - - -	Prof. Ohm, B.A., F.R. Met. Soc.
Cronkbourne, Isle of Man - -	A. W. Moore, M.A., J.P.
Cullompton - - - -	Thos. Turner, J.P., F.R. Met. Soc.
Dublin - - - - -	Major Kirkwood, R.E.
Durham - - - - -	H. J. Carpenter.
Eastbourne - - - -	R. Sheward, F.R. Met. Soc.
Falmouth Observatory - - -	E. Kitto, F.R. Met. Soc.; for the R. Cornwall Polytechnic Soc.
Geldeston, Beccles - - -	E. T. Dowson, F.R. Met. Soc.
Glasgow - - - -	Prof. R. Grant, M.A., LL.D., F.R.S.
Hastings - - - -	H. Colborne, M.R.C.S.
Hillington - - - -	Rev. H. E. B. Ffolkes, M.A., F.R. Met. Soc.
Jersey (St. Helier's) - - -	Capt. Bichard, Harbour Master.
Kew Observatory - - -	G. M. Whipple, B.Sc., F.R.A.S.; for the Kew Committee.
Leicester (Thurcaston) - - -	Rev. T. A. Preston, M.A., F.R. Met. Soc.
Llandudno - - - -	J. Nicol, M.D., J.P., F.R. Met. Soc.
London, Bunhill Row - - -	Messrs. de la Rue.
„ Westminster - -	The Staff, Meteorological Office.
Marchmont - - - -	P. Loney.
Markree Castle - - - -	A. Marth, F.R.A.S.; for Col. E. H. Cooper, F.R.A.S.
Newton Reigny (Penrith) - -	T. G. Benn, F.R. Met. Soc.
Oswald Kirk, Yorkshire - - -	R. Thompson.
Oxford - - - - -	E. J. Stone, F.R.S.
Parsonstown - - - -	O. Boeddicker, Ph.D.; for the Earl of Rosse, K.P., F.R.S.
Plymouth - - - -	J. Merrifield, LL.D., F.R.A.S.
St. Ann's Head - - - -	S. Blake.
Southampton - - - -	Sir C. Wilson, Col. R.E., K.C.B., F.R.S.
Stonyhurst - - - -	Rev. W. Sidgreaves.
Stornoway - - - -	John Forbes.
Sutton Coldfield - - - -	C. F. Marston, C.E.
Swanbister (Orkney) - - -	W. Irvine Fortescue.

Station.	Observer.
Valencia Island - - - -	J. E. Cullum, F. R. Met. Soc.
Westgate-on-Sea - -	J. Norman Lockyer, F.R.S.
Worksop - - -	H. Mellish, F.R. Met. Soc.
York - - - - -	J. E. Clarke, B.A., B.Sc.
Georgetown, Demerara - - -	G. S. Jenman.

In addition, the number of hours sunshine recorded each day is reported from the following Stations :—

Glencarron - - - -	D. D. Munro.
Fort Augustus - - - -	Rev. E. G. Cody, O.S.B.
Braemar - - - -	J. A. Aitken, J.P.
Stowell - - - -	Rev. H. J. Poole, F.R. Met. Soc.

APPENDIX XVI.

Methods followed in dealing with Meteorological Returns from Land Stations in the British Isles.

These stations are of five classes, as stated on page 16.

I.—*Observatories continuously observing all the Meteorological Elements.*

Returns from observatories.

Hourly measurements of the curves obtained from the self-recording instruments at the observatories of the Office are made by the observers at each station, on printed forms supplied for the purpose, which, together with the curves, are forwarded to the Office weekly. They comprise measurements of the barograms, of the dry bulb and wet-bulb thermograms, of the anemograms, and of the rain-gauge curves.

Examination of returns.

The measurements are subjected to a careful examination in order to ensure as far as possible their accuracy, and the regulations which have been adopted to secure this end are in the main the same as those which will be found in the Report of the Office for 1868. They comprise rules for the guidance of observers, as well as of the assistants charged with the examination of the work at the Office. Attention need be called here to only two of these rules, viz., (*a*) the use of subsidiary sheets on which are entered the results of a second set of measurements of the curves made after, and quite independently of, the first set, and with a different scale, the two sets of measurements being afterwards compared together, and any differences found inquired into and set right; and (*b*) the re-measurements of the curve made by the assistants at the Meteorological Office, and which always amounts to 40, and in doubtful cases to many more, per month, for each element. The attention of the observers is always drawn to such errors as may be detected, and to any failures in the continuity of the curves arising from failure of the light, stoppage of the clock, defective photography, faulty action of the wet-bulb thermometer, &c.; a report containing the results of the examination of each Observatory being also submitted to the Council periodically. The curves and tabulations are eventually bound and stored in the Office.

Results of examination and report to Council.

In connexion with this work should be mentioned the general watch which has to be kept over the working of the observatories and of the instruments, not only to secure uniformity amongst them and observance of rules, but also to guard against small changes which are liable to occur at certain times, especially with the thermographs, and which may affect the scale-values of the instrument or the datum lines used for the tabulation of the curves. About twice a year this work calls for special examination, entailing some considerable time and occasionally the engraving of new scales for measuring the curves. General supervision of observatory work.

The photographic curves are also used in the harmonic analyser; and for this purpose the barograms require a slight special preparation. Harmonic analyser.

Method of dealing with the Numerical Results from the Self-recording Observatories.

In dealing with the tabulations the first step is to go over the sheets and fill up by interpolation, wherever possible, any gaps or breaks in the continuity of the record. Interpolations.

The record having been made as complete as possible, the daily, five-daily, and monthly means of the barometer and of the dry-bulb and wet-bulb thermometers are deduced. Means.

The hourly vapour tension is then computed by an expansion of Glaisher's Hygrometrical Tables, prepared in the Office, and the work is independently checked. Vapour tension.

A copy is next prepared of the above-mentioned hourly measurements of the barometer, dry-bulb and wet-bulb thermometers, wind and rain curves, and of the computed values of vapour tension. To these are added the daily means of the three first-mentioned elements, the extremes and daily range of pressure and temperature, and the daily totals of rainfall, and the whole series is printed and published under the title of "Hourly readings from the self-recording Instruments at the Four "Observatories under the Meteorological Council." Hourly Readings.

To ensure accuracy the sheets are read over in proof with the original measurements of the curves. The interpolated readings are printed in *italic* type, but no distinguishing mark is affixed to means which are partly based on them. When the gap in the record is too long to be dealt with by an interpolation of the missing hourly readings, the mean for the day is obtained either from the maximum and minimum readings for the day, or by an interpolation from the adjacent daily means, and the result thus obtained is printed as an approximation.

The five-daily, monthly, and annual means, together with the absolute extremes of pressure and temperature for each month, are printed as part of the "Hourly Readings." The tables are repeated in French measures. Annual Tables.

The gale tables printed in the text of the Quarterly Weather Report, which show the extent, duration, and degree of severity of all the stronger gales, are prepared from the tabulations of the anemograms received from the self-recording observatories, together with those received from the extra anemographic stations. Tables for the Quarterly Weather Report. Gale tables.

II.—*Anemographic Stations at which the Wind is recorded continuously.*

The anemograms received from the stations enumerated on pages 108 *et seq.* are regularly examined and tabulated in the Office, and the sheets bound up in volumes. Besides special inquiries on legal and other points

that from time to time arise, and in which these documents are of high importance, the tabulations are always employed in the preparation of the summary of weather and gale tables for the Quarterly Weather Report. They are also regularly used in the checking of the Storm Warnings issued by the Office.

III.—*Land Stations of the Second Order.*

Origin and progress of system.

Ever since the year 1866 returns of more or less completeness have been received from land stations in the United Kingdom. In that year there was only one station, but by 1871 the number had increased to 15, and five years later to 49, including 14 stations belonging to the Royal Meteorological Society, copies of the returns from which were sent to the Office under a special arrangement with the Society.

At the end of the present year the total number of stations was 97, including 17 belonging to the Royal Meteorological Society and 19 belonging to the Scottish Meteorological Society.

This is an increase of 20 stations as compared with the previous year, which is mainly due to the fresh arrangement mentioned on page 19.

It must, however, be observed that while this number is exclusive of the self-recording observatories and of the anemographic stations, it includes several others from which only very scanty information is received.

The stations are distributed as follows: 43 in England, 4 in Wales, 26 in Scotland, and 24 in Ireland.

The methods followed with regard to the examination and publishing of these returns have been fully detailed in previous reports, and need not now be repeated. The only changes introduced into the volume at present in hand, namely, that for 1886, refer to the barometer readings, which are for the first time given at station-level instead of being reduced to the mean sea-level; and to the humidity, where the depression of the wet-bulb is now shown, the international forms A and B being modified accordingly.

This volume (1886) will contain returns from 66 stations, a larger number than has been included in any volume that has preceded it.

Arrangements have been made under which it is hoped that the arrears of this publication will be rapidly reduced.

Reports from 11 of the Irish stations are regularly supplied to the Registrar-General for Ireland for his Weekly and Quarterly Returns.

New stations.

When an application for the adoption of a new station is received, a schedule is forwarded to the observer containing a series of questions as to the outfit of the station, the exposure of the instruments, and the influence likely to be exerted on their indications by surrounding objects, such as houses and trees. Only mercurial barometers are accepted, and only such as have been duly verified. All thermometers must have been tested at Kew. A plan of the station, showing the positions of the instruments with regard to neighbouring objects, is also required.

On the return of this schedule the answers are considered, and, where necessary, alterations are advised.

If, however, the existing arrangements are satisfactory, tables for reducing the barometer readings to 32° Fahrenheit at mean sea level are prepared and duplicates sent to the observer, together with a set of Hygrometrical Tables, and a copy of "Instructions in the Use of Meteorological Instruments."

The first returns are compared and examined with special care, and a report of the result of the examination is forwarded to the observer, with instructions how best to improve and complete the returns.

There are still many parts of the British Islands very poorly repreented by the existing stations, and any information for these districts would be valuable.

Sunshine records.

The daily records of sunshine which are now received from 39 Stations in the British Islands are examined generally to guard against accidental changes in the adjustment of the instruments. Notes explaining any omission or accidental defect are added to the cards if required, and after their receipt has been acknowledged, they are duly stamped and dated and then stored in the Office.

Weekly totals.

A tabulation of these curves is published as part of the Weekly Weather Report, mentioned in Appendix VIII., and for those stations which are also Stations of the Second Order the monthly totals of bright sunshine in hours, together with the percentage of its possible duration, are published as Part IV. of "Returns from Stations of the Second Order." A table showing the daily amount of sunshine at Bunhill Row, one of the London stations, is also prepared quarterly for the Royal Meteorological Society.

Inspection.

The Stations of the Second Order are regularly inspected, the attention of the inspector being directed by the Office to any special point which may require investigation.

IV.—*Telegraphic Reporting Stations.*

Full particulars relating to these stations, the information received from them, and the method of dealing with that information, will be found in Appendix VII. to the Report for the year 1888–9. A paragraph in that Appendix (p. 60) explains the use that is made of the monthly schedules sent in by the observers.

V.—*Extra Stations.*

No returns from Stations of the Fifth Class are published by the Office, but some of them are regularly used in the checking of the Storm Warnings, and all are available for any special investigation that may be taken up.

The rainfall values at these stations are, however, copied and supplied to Mr. Symons, F.R.S., for publication in "British Rainfall."

APPENDIX XVII.

LIST OF DOCUMENTS RELATING TO THE LAND METEOROLOGY OF THE BRITISH ISLANDS, RECEIVED DURING THE YEAR ENDING MARCH 31ST, 1890.

Stations.	Observers.	Nature of Information received.	Notes.
CLASS I. †Valencia	J. E. Cullum, F.R. Met. Soc.	Continuous records of pressure, temperature, wind, sunshine, and rain, with eye observations of the clouds and notes on the weather.	
†Aberdeen	Prof. C. Niven, M.A., F.R.S.		
†Falmouth	E. Kitto, F.R. Met. Soc.		
†Kew	G. M. Whipple, B.Sc., F.R.A.S., F.R. Met. Soc.		
†Glasgow	Prof. R. Grant, M.A., LL.D., F.R.S.	Continuous records of pressure, temperature, wind, sunshine, and rain.	
†Stonyhurst	The late Rev. S. J. Perry, F.R.S., and Rev. W. Sidgreaves, S. J.		
CLASS II. †Armagh	J. L. E. Dreyer, Ph.D., F.R.A.S.	Continuous record of wind, rainfall, and sunshine.	
Alnwick Castle	Lt.-Col. F. Holland, for the Duke of Northumberland, K.G.	Continuous record of wind (direction and velocity).	
†Dublin (Phœnix Park)	Major Kirkwood, R.E.	" "	
†Fleetwood	M. S. Gaulter, C.E.	" "	
†Holyhead	Hugh Williams, C.E.	" "	
†North Shields	Capt. W. Harrison	" "	
†Scilly	The late W. Thomas and A. Hicks	" "	
†Swanbister (Orkney)	W. Irvine Fortescue	" "	
†Yarmouth	G. T. Watson	" "	
Heligoland	J. J. Friederichs	" "	
†Kilkenny Castle	The Marquis of Ormonde, K.P.	Continuous record of pressure.	
London	The Athenæum Club	" "	
Nottingham	E. C. Patchett	" "	
†Waterford	The Harbour Authorities	" "	
CLASS III. †Armagh	J. L. E. Dreyer, Ph.D., F.R.A.S.	Regular observations at 9 a.m. and 9 p.m. of pressure, temperature (dry-bulb and wet-bulb), wind, cloud and weather, with the daily maxima and minima of temperature, the daily rainfall, and general remarks on the weather.	
Aysgarth	Rev. Fenwick W. Stow, M.A., F.R. Met. Soc.		
†Braemar	James Aitken, J.P.		
†Brookeborough	W. Ferguson, for Sir Victor Brooke, Bt., F.L.S.		
†Carmarthen	G. J. Hearder, M.D.		

LIST OF DOCUMENTS—*continued.*

Stations.	Observers.	Nature of Information received.	Notes.
†Cronkbourne, I. of Man	A. W. Moore, M.A., J.P.	Regular observations at 9 a.m. and 9 p.m. of pressure, temperature (dry-bulb and wet-bulb), wind, cloud and weather, with the daily maxima and minima of temperature, the daily rainfall, and general remarks on the weather.	
†Dartmoor	F. W. S. Stone, M.B.		
†Douglas, Isle of Man	Thos. Keig		
†Dublin (City)	J. W. Moore, M.D., F.R. Met. Soc.		
†Dublin (Phœnix Park)	Serjt. Lipscombe, for Major Kirkwood, R.E.		
†Dublin (Glasnevin)	F. W. Moore, M.R.I.A.		
†Dundee	W. Ross McKelvie		
Dunrobin Castle	D. Melville, for the Duke of Sutherland, K.G.		
†Durham	H. J. Carpenter		
†Eastbourne	R. Sheward, F.R. Met. Soc.		
†Edgeworthstown	J. M. Wilson, M.A., J.P.		
†Epsom (Royal Med. College).	J. S. Jackson and E. C. Montgomery		
Geldeston (Beccles)	E. T. Dowson, F.R. Met. Soc.		
†Glasgow	Prof. R. Grant, M.A., LL.D., F.R.S.		
Hillington, Norfolk	Rev. H. E. B. Ffolkes, M.A., F.R. Met. Soc.		
Ladylaw, Hawick	W. R. Wilson		From January 1890.
Laudale (Argyleshire)	A. Fletcher, for T. H. G. Newton, M.A., J.P.		
Liverpool	J. Hartnup, F.R.A.S., F.R. Met. Soc.		From August 1889.
†Londonderry	J. Conroy, F.R. Met. Soc.		
Margate	J. Stokes, F.R. Met. Soc.		
†Markree Castle, Sligo	A. Marth, F.R.A.S., for Col. Cooper, F.R.A.S.		
†Newton Reigny (Penrith).	T. G. Benn, F.R. Met. Soc.		
†Parsonstown	O. Boeddicker, Ph.D., for the Earl of Rosse, K.P., F.R.S.		
†Prestwich (Manchester)	T. R. H. Clunn, M.D., F.R. Met. Soc.		
†St. David's, Pembroke	W. P. Propert, LL.D., F.G.S., F.R. Met. Soc.		
Scarborough	Allan Rowntree		
†Seaham	G. H. Aird		
Southampton	J. T. Cook, for Dir. Gen. of Ordnance Survey.		
Stokesay	Miss M. A. Digges La Touche		

LIST OF DOCUMENTS—*continued.*

Stations.	Observers.	Nature of Information received.	Notes.
†Stonyhurst - -	The late Rev. S. J. Perry, F.R.S., and Rev. W. Sidgreaves, S. J.	Regular observations at 9 a.m. and 9 p.m. of pressure, temperature (dry-bulb and wet-bulb), wind, cloud and weather, with the daily maxima and minima of temperature, the daily rainfall, and general remarks on the weather.	
†Sutton Coldfield -	J. Fletcher, C.E., and C. F. Marston, C.E. -		
†Swanbister - -	W. Irvine Fortescue - - - -		
Uppingham - -	Rev. G. H. Mullins, M.A., F.R. Met. Soc. -		
Wolfelee (Roxburghshire).	M. W. Cockburn, for Lady Elliott - -		
†York - - -	J. Wright, for Yorkshire Phil. Soc. - -		
CLASS IIIa. †Babbacombe, Devon.	E. E. Glyde, F.R. Met. Soc. - - -		
Bennington, Herts -	Rev. J. Dunne Parker, LL.D., F.R. Met. Soc.-		
Berkhamsted -	E. Mawley, F.R.H.S., F.R. Met. Soc.- -		
†Buxton -	E. J. Sykes, M.B., F.R.A.S. - - -		
Callton Mor -	J. Russell, for J. Malcolm, of Poltalloch, M.P.		
Cargen (Dumfries) -	P. Dudgeon, F.R.S.E., and Alex. Peacock -		
Cheadle - -	J. C. Philips - - - -		
†Cheltenham - -	R. Tyrer, B.A., F.R. Met. Soc. - -		
†Churchstoke - -	P. Wright, F.C.S., F.R. Met. Soc. - -		
Cramlington - -	W. Bonallo, F.R. Met. Soc. - - -	Monthly means and summaries on Form B. of observations taken at 9 a.m. and 9 p.m. each day as above.	
†Fort Augustus -	Rev. E. G. Cody, O.S.B. - -		
†Fort William - -	C. Livingston, for Directors of Ben Nevis Observatory.		
†Glencarron - -	D. D. Munro, for the Lord McLaren - -		
†Glenlee (Kirkcudbrightshire).	W. Melville, for George Maxwell - -		
Gordon Castle -	J. Webster, for the Duke of Richmond, K.G. -		
†Killarney - -	Archdeacon G. R. Wynne, M.A., F.R. Met. Soc.		
†Lairg - -	William Ross, for Duke of Sutherland, K.G. -		
Lednathie (Forfarshire).	W. Morrison, for Stormonth Darling, Q.C. -		

LIST OF DOCUMENTS—*continued.*

Stations.	Observers.	Nature of Information received.	Notes.
⚓ Lissan (Co. Tyrone) -	Sir Nathaniel Staples, Bart. - - -	Monthly means and summaries on Form B. of observations taken at 9 a.m. and 9 p.m. each day as above.	
⚓†Llandudno - -	J. Nicol, M.D., F.R. Met. Soc. - -		
⚓†Marchmont - -	Peter Loney, for Sir Hugh P. Campbell, Bt. -		
⚓†Ochtertyre - -	G. Croucher, for Sir Patrick Keith Murray, Bt.		
⚓†Pinmore - -	Peter Donald, for Capt. Hamilton - -		
⚓ Rosewell - -	R. W. D. Cameron, M.D. - - -		
⚓ Rothesay (Isle of Bute)	James Kay - - - -		
⚓†Rousdon - -	C. E. Peek, M.A., F.R.A.S., F.R. Met. Soc. -		
⚓ Wakefield - -	H. Clarke, L.R.C.P., F.S.S., F.R. Met. Soc. -		
CLASS IV. The Telegraphic Stations, see List on page 71.			
CLASS V. Baltimore -	J. Halsey - - - - -	Pressure, temperature, wind, and weather, once daily.	
Bolton - -	W. W. Midgley, F.R. Met. Soc. - -	Full monthly summary.	
Bray (Co. Wicklow) -	Coast Guard - - - - -	Pressure and temperature four times daily, with wind and weather twice daily.	From December 1889.
Castletownsend -	Coast Guard - - - - -	Pressure and temperature four times daily, and wind twice daily.	
Chatham (School of Military Engineering).	Lance Corporal D. Harrington, for Instructor in Surveying.	Full return for 9 a.m.	
Cooper's Hill (Egham)	Prof. H. McLeod, F.R.S. - - -	Full return for 9 a.m. and 3 p.m.	
Crookhaven - -	Coast Guard - - - - -	Pressure and temperature four times daily, and wind twice daily.	
Crosshaven - -	J. W. Bridle - - - - -	Pressure, temperature, and wind, twice daily.	
Cuckfield - -	John Howe - - - -	Daily rainfall.	
Ennis - -	J. Hill, M.I.C.E., F.R. Met. Soc. - -	Daily rainfall.	

LIST OF DOCUMENTS—*continued.*

Stations.	Observers.	Nature of Information received.	Notes.
Galway - -	Coast Guard - - - - -	Pressure and temperature four times daily, with wind.	
Gorleston - -	R. J. C. Day - - - - -	Pressure and wind twice daily.	
Harpenden - -	T. Wilson, F.R. Met. Soc. - - -	Pressure, temperature, and wind, twice daily, with rainfall.	
Haslar Hospital -	G. Coppen - - - - -	Pressure and temperature four times daily.	
†Killybegs - -	Coast Guard - - - - -	Pressure, temperature, wind, and weather once daily.	July to December 1889.
Knightstown (Valencia).	Coast Guard - - - - -	Pressure, wind, and weather once daily.	
North Arran - -	Coast Guard - - - - -	Pressure, temperature of air and sea four times daily, with wind and weather at noon.	
Rosehearty - -	" " - - - - -	Pressure once daily - - - -	May to December 1889.
†Rugby - -	W. N. Wilson, M.A., and H. P. Highton, B.A.	Full set of 9 a.m. observations with 9 p.m. temperatures.	
St. Leonards - -	H. Colborne, M.R.C.S. - - -	Full set of 9 a.m. observations.	
Schull - -	Coast Guard - - - - -	Pressure, temperature, and wind twice daily.	
Sheffield (Weston Park)	Elijah Howarth, F.R.A.S. - - -	Full return for 9 a.m. and 6 p.m.	
Stamford (Ketton Hall)	Fred. Coventry - - - -	Pressure, temperature (max., min., min. on grass), rainfall, and wind once daily.	
Stranraer -	P. Doran - - - - -	Pressure, wind, and weather once daily.	
Sudbury - -	W. Bayley Ransom - - - -	Pressure, temperature (dry-bulb, max., min.), wind, cloud, and rainfall, once daily, with general remarks.	
Symbister, Shetland -	J. S. Nicolson - - - -	Pressure and temperature twice daily.	
Tarbert, Harris -	Donald Bethune - - - -	Pressure and wind twice daily.	
Totland Bay - -	John Dover, B.A., F.R. Met. Soc. - -	Full return for 9 a.m.	
Union Hall (Glandore)	Coast Guard - - - - -	Pressure, temperature, and wind, twice daily.	

NOTE.—The Stations marked "𝔐" belong to the Royal Meteorological Society; those marked "𝔖" belong to the Scottish Meteorological Society; those marked thus † have been inspected during the year.

APPENDIX XVIII.

Accessions to the Library during the Year ending 31st March 1890.

‖ **Abercromby, Hon. R.**—On Meldrum's rules for handling ships in the hurricanes of the Southern Indian Ocean; with researches on the nature of hurricanes generally. la. 8°. (*Journ. Scott. Meteor. Soc.*, 3*rd ser. No.* vi.)

* ——— Seas and skies in many latitudes or wanderings in search of weather. 8°. London, 1888.

‖ **Aitken, J.**—On improvements in the apparatus for counting the dust particles in the atmosphere. Parts i. and ii. 8°. (*Proc. R. Soc. Edinb.*, xvi., 1889, *p.* 135.)

Algiers, Service Central Météorologique de l'Algérie.—Bulletin mensuel. 1888, Jan.—Dec. sm. f°. s.l.e.a.

[Algiers, Service Météorologique du Gouvernement Général de l'Algérie.]—Bulletin météorologique de l'Algérie. 1889, Jan. 1—Dec. 31. oblong sm. f°. Sheets.

(Allahabad, Meteorological Office.)—Administration report of the Meteorological Reporter to Government, North-Western Provinces and Oudh, for the year 1888–89. sm. f°. s.l.e.a.

[——— ———] Brief sketch of the meteorology of the North-Western Provinces, Oudh and Eastern Rajputana, for the year 1888. sm. f°. s.l.e.a.

* **Allan, W.**—Weather wisdom from January to December. Wherein will be found much that is curious, entertaining, and instructive. sm. 8°. London, [1889.]

Altitudes, Table of. sm. 8°. Sheet.

American Meteorological Journal.—A monthly review of meteorology, medical climatology, and geography. Edited by **M. W. Harrington** and **A. L. Rotch.** Vol. V., 1888–1889. la. 8°. Ann Arbor, s.a.

Amsterdam, Kon. Nederlandsch Aardrijkskundig Genootschap.—Tijdschrift . . . onder redactie van **C. M. Kan** en **J. Æ. C. A. Timmerman.** Tweede serie. Deel vi. Meer uitgebreide artikelen. 8°. Leiden, 1889.

——— ——— Tijdschrift . . . onder redactie van **C. M. Kan** en **J. Æ. C. A. Timmerman.** Tweede serie. Deel vi. Veralagen en aardrijkskundige mededeelingen. 8°. Leiden, 1889.

‖ **Angot, A.**—Étude sur la marche diurne du baromètre. la. 4°. (*Ann. Bureau centr. météor. France*, 1887, I., *p.* B. 237.)

Arata, P. N.—El clima y las condiciones higiénicas de la ciudad de Buenos Aires. la. 8°. Buenos Aires, 1889.

Augustin, F.—Untersuchungen über die Temperatur von Prag. la. 8°. [*Sitzungsb. k. böhm. Gesellsch. Wissensch. math.-naturw. Cl.*, 1889, *Bd.* ii., *p.* 357.]

Avignon, Commission Météorologique du Département de Vaucluse.—Compte-rendu pour l'année 1888. sm. f°. s.l.e.a.

Azambuja, G. A. de.—Annuario da Provincia de Rio Grande do Sul para os annos de 1889 e 1890. 2 vols. sm. 8°. Porto Alegre, 1888–89.

* ‖ **Barber, S.**—The outline of cloud forms: the electric cumulus, anvil cloud, and rain-ball. 8°. (*Pop. Sc. Rev.*, ? *year*, *p.* 359.)

Batavia, Magnetical and Meteorological Observatory.—Observations. . . . Published under the direction of Dr. **J. P. Van der Stok.** Vol. xi., 1888. f°. Batavia, 1889.

Note.—Books marked * have been acquired by purchase; the others are donations from institutions, societies, or authors. Those marked ‖ are excerpt papers, extra copies of which have been separately printed.

In some cases additional publications have been received besides those specified, but only completed volumes or years are given here.

Batavia, Observatorium. — Regenwaarnemingen in Nederlandsch-Indië. Tiende Jaarg. 1888. Door **J. P. Van der Stok.** 8°. Batavia, 1889.

Title page and preface in the English language also.

|| **Bayard, F. C.**—Tables and diagrams illustrating the diurnal range of barometric pressure in the British Isles during the years 1876–1880. Calculated from the records of nine meteorological observatories in Great Britain and Ireland. 1a. 4°. (*Quart. Weather Rep.*, 1880, *Part* i., *App.* iii. *p.* [19].)

|| **Bebber, W. J. van.**—Abhängigkeit der Stärke des Unterwindes von der Unterlage. 1a. 8°. (*Ann. Hydr. mar. Meteor.*, 1889, *Dez.*)

* ——— Lehrbuch der Meteorologie für Studierende und zum Gebrauche in der Praxis. 1a. 8°. Stuttgart, 1890 [1889].

* || **Becquerel, [A. C.]**—Recherches sur les causes de l'électricité atmosphérique et terrestre et sur les effets chimiques produits en vertu d'actions lentes avec ou sans le concours des forces électriques. 4°. (*Mém. acad. sc., Paris,* xxvii., 2e *partie*, 1856, *p.* 153.)

* || ——— Recherches sur la température de l'air au Nord, au Midi loin et près des arbres. 4°. [*Mém. acad. sc., Paris,* xxxii., *p.* 393.]

* || ——— De la température moyenne d'un lieu, et des difficultés que présente sa détermination. 3e mémoire. 4°. [*Mém. acad. sc., Paris,* xxxii., *p.* 495.]

* || [———] De la température de l'air à 6 heures du matin et au lever du soleil. 4e mém. 4°. [*Mém. acad. sc., Paris,* xxxii., *p.* 537.]

* || ——— De la température de l'air dans les couches atmosphériques voisines du sol. 5e mém. 4°. [*Mém. acad. sc., Paris,* xxxii., *p.* 555.]

* || ——— De la température de l'air et de celle des couches superficielles de la terre. 6e mém. 4°. (*Mém. acad. sc., Paris,* xxxii., *p.* 599.)

* || ——— Sur la température de l'air et ses variations suivant l'état du sol. 7e mém. 4°. (*Mém. acad. sc., Paris,* xxxii., *p.* 665.)

* || ——— Sur la température des couches terrestres au-dessous du sol jusqu'à 36 mètres de profondeur. 8e mém. 4°. (*Mém. acad. sc., Paris,* xxxii., *p.* 721.)

* || ——— Note sur la psychrométrie électrique. 4°. [*Mém. acad. sc., Paris,* xxxii., *p.* 569.]

* || ——— Mémoire sur les zones d'orages à grêle dans les départements du Loiret, de Loir-et-Cher et de Seine-et-Marne et sur l'influence qu'exercent sur elles plusieurs causes locales. Communiqué . . . 13 nov. 1865. 4°. (*Mém. acad. sc., Paris,* xxxv., 1866, *p.* 689.)

* || ——— Mémoire sur les zones d'orages à grêle dans les départements d'Eure-et-Loir et Loir-et-Cher. 4°. (*Mém. acad. sc., Paris,* xxxvi., 1870, *p.* 83.)

* || ——— Mémoire sur les pluies. 4°. [*Mém. acad. sc., Paris,* xxxvi., 1870, *p.* 121.]

* || ——— Recherches sur la cause des phénomènes lumineux de l'atmosphère et des espaces planétaires, pouvant avoir une origine électrique. Lu . . . 12 nov. 1872. 4°. (*Mém. acad. sc., Paris,* xxxviii., 1873, *p.* 395.)

* || ——— **et E.**—Mémoire sur la température des sols couverts de bas végétaux ou dénudés. Lu . . . 6 nov. 1871. 4°. [*Mém. acad. sc., Paris,* xxxviii., 1873, *p.* 251.]

* || ——— ——— Mémoire sur la température des sols couverts de bas végétaux et dénudés pendant une saison pluvieuse, observée avec le thermomètre électrique. 4°. [*Mém. acad. sc., Paris,* xxxviii., 1873, *p.* 633.]

* || ——— ——— Mémoire sur la température de deux sols semblables, l'un dénudé, l'autre couvert de gazon, observée avec le thermomètre électrique pendant les années, 1873–74. Lu . . . 13 fév. 1874 et 29 mars 1875. 2 parts. 4°. (*Mém. acad. sc., Paris,* xl.)

* || ——— ——— Mémoire sur la température de l'air à la surface du sol et de la terre jusqu'à trente-six mètres de profondeur, ainsi que sur la température de deux sols, l'un dénudé, l'autre couvert de gazon, pendant les années 1875–77. Lu . . . . 1875, 1877, 1878. 3 parts. 4°. (*Mém. acad. sc., Paris,* xli.)

For continuation see *Becquerel, E. et H.*

* || ——— ——— Observations de température faites au Muséum d'Histoire Naturelle pendant les années météorologiques 1875–1877 avec les thermomètres électriques placés sous le sol depuis la surface jusqu'à 36 mètres de profondeur ainsi que dans l'air au nord et à 20 mètres au-dessus du sol. Extrait Mém. acad. sc. 1876–78. 1a. 4°. (*Nouv. arch. mus. hist. nat., Paris,* 2e *sér.*, ii., *p.* 157.)

For continuation see *Becquerel, E. et H.*

* ‖ **Becquerel, E. et H.**—Mémoire sur la température de l'air à la surface du sol et de la terre jusqu'à trente-six mètres de profondeur, ainsi que sur la température de deux sols, l'un dénudé, l'autre couvert de gazon, pendant les années 1878–1880. 3 parts. 4°. (*Mém. acad. sc., Paris*, xlii.)

For previous years see *Becquerel, [A. C.] et E.*

* ‖ ——— ——— Observations de température faites au Muséum d'Histoire Naturelle pendant les années météorologiques 1878–1882 avec les thermomètres électriques placés sous le sol, depuis la surface jusqu'à 36 mètres de profondeur, ainsi que dans l'air, au nord, et à 20 mètres au-dessus du sol. Extrait des Mém. acad. sc. 1879–83. 4 parts. la. 4°. (*Nouv. arch. mus. hist. nat., Paris*, 2e *série*, iii. *p.* 297 ; iv. *p.* 359 ; v. *p.* 389 ; vi. *p.* 299.)

For previous years see *Becquerel, [A. C.] et E.*

Belize.—Summary of meteorological observations at St. Joseph's Observatory during the months of Jan.—Dec. 1888–89. 4°. Sheets. (*The Angelus, Belize*, iv.–v., 1888–89.)

‖ **Berg, E.**—Die Gewitter Russlands im Jahre 1886. Der Akademie vorgelegt am 7 Nov. 1889. sm. f°. (St. Petersburg), 1890. (*Repert. Meteor., Bd.* xiii., *No.* 5.)

Berlin, Deutsche meteorologische Gesellschaft.—Berliner Zweigverein der Deutschen meteorologischen Gesellschaft. Siebentes Vereinsjahr, 1890. 8°. Berlin, 1890.

——— **hydrographisches Amt des Reichs-Marine-Amts.**—Allgemeine Inhalts-Uebersicht und ausführliches Sach- und Namen-Register der Jahrgänge 1873–1888 der Annalen der Hydrographie und Maritimen Meteorologie. Ann. der Hydr. und mar. Meteor., 1889, Heft vii. la. 8°. Berlin, 1889.

——— ——— Annalen der Hydrographie und maritimen Meteorologie. xvii. Jahrg. 1889. la. 8°. Berlin, s.a.

——— **Königlich Preussisches meteorologisches Institut.**—Ergebnisse der meteorologische Beobachtungen im Jahre 1887. Herausgegeben von . . . **W. von Bezold.** la. 4°. Berlin, 1889.

‖ ——— ——— Witterung nach den Beobachtungen des königlichen meteorologischen Instituts. 1889, Jan.—Dec. la. 4°. (*Statist. Korresp.*)

Bibliothèque Universelle [et Revue Suisse]. Archives des sciences physiques et naturelles.—Troisième periode. Tomes xxi.–xxii. 2 vols. 8°. Genève, 1889.

‖ **Billwiller, R.**—Vergleichende Resultate der durch Schätzung erhaltenen Daten über den mittleren Bewölkungsgrad des Himmels und der Aufzeichnungen des Sonnenscheinautographen. sm. 8°. (*Vierteljahrs. Zürcher naturf. Gesellsch.*, 1888, *p.* 293.)

‖ **Birkner, O.**—Die wissenschaftlichen Erhebungen zur Wasserkatastrophe in der sächsischen Oberlausitz am 18 Mai 1887. sm. f°. (*Meteor. Zeitschr.*, 1889, *Okt.*, *p.* 361.)

‖ ——— Spezieller Bericht über die Forschungen bezüglich der Gewitter- und Hagelerscheinungen während des Jahres 1887. la. 4°. (*Jahrb. k. sächs. meteor. Inst.*, 1887, *Anh.* 5.)

* **Blanford, H. F.**—A practical guide to the climates and weather of India, Ceylon and Burmah, and the storms of Indian seas, based chiefly on the publications of the Indian Meteorological Department. la. 8°. London, 1889.

‖ **Blodget, L.**—Climatology of Pennsylvania. la. 8°. Harrisburg, 1889. (*Ann. Rep. Sec. Internal Affairs, Penn.*, 1888, *p.* A 107.)

Bombay, Government Observatory.—Magnetical and meteorological observations made at the Government Observatory, Bombay, in the year 1887, under the direction of **C. Chambers** and **C. Chambers, Junior.** la. 4°. Bombay, 1889.

(——— ———) Report on the condition and proceedings of the Government Observatory, Colába, for the year which ended with the 30th June, 1889. f°. s.l.e.a.

Borneo.—Handbook of British North Borneo . . . With an introduction by **Sir R. Alcock.** 8°. London, 1886.

* ‖ **Brewster, Sir D.**—Report on the hourly meteorological register kept at Leith Fort in the years 1826 and 1827. Read 19 Feb. 1866. 4°. [*Trans. R. Soc. Edinb.*, xxiv., 1867, *p.* 351.]

Brisbane, Chief Weather Bureau.—Meteorological instructions by **C. L. Wragge.** sm. f°. Brisbane, 1889.

——— ——— Meteorological report for 1887. sm. f°. s.l.e.a.

——— ——— Telegraphic code and special notice to observers. f°. (Brisbane, s.a.)

——— **Post and Telegraph Department, Meteorological Branch.**—Brisbane observatory, Wickham Terrace. Meteorological synopsis. 1889, Jan.–Dec. f°. Sheets.

——— ——— Table of rainfall during the months Jan.—Dec., 1889. f°. Sheets.

——— ——— Weather chart of Australasia. 1889, Jan. 1—Dec. 31. la. f°. Sheets.

Brussels, Observatoire Royal.—Annuaire . . . par **F. Folie.** 1886–1889. 53e–57e Années. 5 vols. 18°. Bruxelles, 1885–90.

——— ——— Bulletin météorologique. 1889, Jan. 1—Dec. 31. f°. Sheets.

Buchan, A.—Report on atmospheric circulation. See *Edinburgh Challenger Office.*

Bucharest, Academia Romana.—Analele. Serie ii. Tom. x., 1887–88. 2 vols. 4°. Bucuresci, 1889.

——— **Institutul Meteorologic al Romaniei.**—Analele . . . de **S. C. Hepites.** Tom. iii., 1887. la. 4°. Bucuresci, 1889.

In the French language also.

——— ——— Instructiuni pentru compunerea telegramelor meteorologice. De **S. C. Hepites.** 8°. Bucuresci, 1885.

——— ———Instructiuni relative la observatiunile asupra fenomenelor vegetatiunei si asupra animalelor pentru climatologia unei regiuni. la. 8°. Bucuresci 1886.

|| ——— ——— Raport asupra lucrărilor Institutului Meteorologic in anii 1886–88. 2nd and 3rd. 2 vols. la. 4°. Bucuresci, 1888–89. (*Anal. Inst. Meteor. Roman., Tom.* i., ii., 1886, 1887.)

In the French language also.

* **Bushell, R.**—Twenty-five years' rainfall in Wirrall, North-West Cheshire. la. 8°. Chester, 1889.

Busin, [P.]—Quelques considérations générales sur les cartes du temps et spécialement sur les types isobariques en Italie. la. 8°. (*Assoc. franç. avanc. sc., Congrès de Nancy,* 1886.)

|| ——— **P.**—Le temperature nell' Emilia, nella Lombardia e nel Veneto. 4°. Bologna, 1888. (*Mem. R. Accad. Sc. Ist. Bologna, serie* iv., *Tom.* ix., 1888, *p.* 431.)

|| ——— Sulle predizioni del tempo. la. 8°. Roma, 1888. (*Riv. Maritt.,* 1888, *Marzo.*)

|| ——— Le temperature in Italia. sm. f°. Torino, 1889. [*Boll. Mens. Osserv. Centr. Moncalieri, Ser.* ii., *vol.* ix., *N.* 4, 9, 10.]

(Calcutta, Meteorological Office, Bengal.)—Administration report of the meteorological Reporter to the Government of Bengal for the year 1888–89. sm. f°. s.l.e.a.

[——— ———] Bay of Bengal weather Chart. 1889, Jan. 1—Dec. 31. sm. f°. Sheets.

——— ——— Bengal daily weather report. 1889. sm. f°. Sheets.

These reports are only published during the rainy season.

(——— ———) Meteorological and rainfall table of the Province of Bengal for the weeks ending January 4, 1889, to January 3, 1890. f°. Sheets.

——— ——— Meteorological and rainfall table of the Province of Bengal for the months of January to December 1889, with annual tables. sm. f°.

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‖ ——— **et Backlund, O.**—Rapport fait à l'académie impériale des sciences par les délégués de la Russie à la conférence générale du mètre, réunie à Paris en septembre 1889. la. 8°. (*Mél. phys. chim. St. Pétersb.*, xiii., *p.* 123.)

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|| ——— Voyage aux salines d'Iletsk et au pays voisin. 8°. (*Compt. rend. soc. géogr. Paris*, 1888, *Nos.* 16 *et* 17.)

|| **Wollny, E.**—Entgegnung, veranlasst durch die Abhandlung des Herrn C. Lang. Welche Zuverlässigkeit besitzt die abendliche Thaupunkts-bestimmung als Anhaltspunkt für Stellung der Nachtfrostprognose? Beob. meteor. Stationen K. Bayern, x., 1888. 8°. (*Forschungen auf dem Geb. Agrik.-phys., Heidelberg, Bd.* xii., *Heft* 1 *u* 2.)

|| ——— Zur Frage der Brauchbarkeit der Thaupunktmethode zur Vorausbestimmung der Nachtfröste. 8°. (*Forschungen auf dem Geb. Agrik.-phys., Heidelberg, Bd.* xii., *Heft* 3 *u* 4.)

|| ——— Untersuchungen über das Verhalten der atmosphärischen Niederschläge zur Pflanze und zum Boden. 8°. (*Forschungen auf dem Geb. Agrik.-phys., Heidelberg,* xii. *Bd., Heft* 5.)

|| ——— Untersuchungen über den Einfluss der Farbe des Bodens auf dessen Feuchtigkeitsverhältnisse und Kohlensäuregehalt. 8°. (*Forschungen auf dem Geb. Agrik.-phys., Heidelberg,* xii. *Bd., Heft* 5.)

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——— **Schweiz. Departement des Innern.**—Graphische Darstellung der schweizerischen hydrometrischen Beobachtungen. 1889. la. f°. Sheets.

For the second half of the year the title is in French.

——— **Schweizerische meteorologische Central-Anstalt.**—Wetterbericht, 1889, Jan. 1—Dec. 31. sm. f°. Sheets.

APPENDIX XIX.

METEOROLOGICAL OFFICE : ACCOUNT of RECEIPTS and PAYMENTS for the yea ending 31st March 1890.

RECEIPTS.	£ s. d.	£ s. d.	PAYMENTS.	£ s. d.	£ s.
Balance from year 1888–89 -		3,468 12 9	ADMINISTRATION:		
Parliamentary Vote - -		15,300 0 0	Payment of Council -	955 18 4	
			Secretary - -	800 0 0	
Repayment of expenses charged under—			Salaries and wages -	801 4 2	
(1.) Incidental expenses -	7 9 0		Rent, fuel, and lighting	714 11 3	
(2.) Special researches -	4 11 8		Incidental and contingent expenses :—		
(3.) Observatories -	8 19 6		Attendance, cleaning, &c. - -	350 8 0	
		21 0 2	Furniture and fittings	154 13 10	
			Expenses incidental to International Meteorological Congress - -	5 2 0	
SUPPLY OF INFORMATION :			Pensions - -	186 16 4	
D.W. Charts and Forecasts -	247 13 9				3,968 18
6 p.m. Charts -	25 0 0		SPECIAL RESEARCHES	- - -	678 6
Information for Press Agencies, &c. -	105 19 10		LAND METEOROLOGY:		
Telegrams -	99 7 1		Observatories and stations - -	1,954 8 1	
		478 0 8	Salaries: —Discussion and reduction of observations - -	1,481 11 0	
					3,435 19
SALE OF INSTRUMENTS, &c.:			WEATHER INFORMATION AND FORECASTS :		
Royal Navy (A)	5 0 1		Telegraphic reports and storm warnings	2,548 4 4	
Mercantile Marine account (B)	66 13 4		Salaries : — Preparation and issue of reports and forecasts -	1,787 17 7	
		71 13 5			4,336
Commissions executed for Colonial and Foreign Institutions, &c. (C) - -		512 18 8	INSPECTIONS:		
Commission charged on work done for Colonies, &c. -		28 1 0	Salaries and travelling expenses - -	- - -	764
			OCEAN METEOROLOGY:		
			Salaries :—Discussion and reduction of observations - -	1,587 16 0	
			Expenses incidental to the supply of instruments :—		
			Proportion for care and issue of instruments - -	200 0 0	
			Royal Navy - -	525 15 1	
			Mercantile Marine -	361 16 3	
			Distant island and coast stations -	6 18 1	
					2,682
			Commissions executed for Colonial and Foreign Institutions, &c. - -	- - -	598 1
			BALANCE:		
			Cash at Bank -	3,333 17 4	
			„ at Office -	82 9 4	
					3,416
	£	19,880 6 8		£	19,880

In the year 1889–90 the sum of 1,606*l.* 9*s.* 5*d.* was paid to the Post Office on account of in and foreign telegrams, allowances to clerks, and rental of private wires.

APPENDIX XX.

LIST OF PUBLICATIONS, &c. issued under the Authority of the Meteorological Council.

OFFICIAL.

No. 1 Report for 1867. Presented to Parliament. 1*s.*
2. Instructions for Meteorological Telegraphy. [Out of Print.]
3. Fishery Barometer Manual. (New edition, 1887.) 6*d.*
4. Charts of Surface Temperature, South Atlantic Ocean. 2*s.* 6*d.*
5. Report for 1868. Presented to Parliament. 5*d.*
6. Report for 1869. Presented to Parliament. 10*d.*
7. Quarterly Weather Report for 1869.—Parts I. to IV. 5*s.* each.
8. Barometer Manual. (Out of print, see Nos. 3, 24, 40, 60, and 61.)
9. Quarterly Weather Report for 1870.—Parts I. to IV. 5*s.* each.
10. Report for 1870. Presented to Parliament. 10*d.*
*11. Contributions to our Knowledge of the Meteorology of Cape Horn and the West Coast of South America. 2*s.* 6*d.*
*12. Currents and Surface Temperature of the North Atlantic Ocean, from the Equator to Lat. 40° N., for each month of the year, with a General Current Chart. 2*s.* 6*d.*
13. A Discussion of the Meteorology of the Part of the Atlantic lying North of 30° N., for the Eleven Days ending 8th February 1870. Price, with Book of Charts, 5*s.*
14. Quarterly Weather Report for 1871.—Parts I. to IV. 5*s.* each.
15. Report for 1871. Presented to Parliament. 10*d.*
16. Quarterly Weather Report for 1872.—Parts I. to IV. 5*s.* each.
17. Report for 1872. Presented to Parliament. 1*s.*
18. Contributions to our Knowledge of the Meteorology of the Antarctic Regions. 2*s.*
19. Quarterly Weather Report, 1873.—Parts I. to IV. 5*s.* each.
20. Charts of Meteorological Data for Square 3. Lat. 0°—10° N. Long. 20° — 30° W., and Remarks to accompany the Monthly Charts, which show the Best Routes across the Equator for each Month, &c. 20*s.*
21. Report of the Proceedings of the Meteorological Congress at Vienna. 1873. 1*s.*
22. Report for 1873. Presented to Parliament. 4*d.*
23. Report of the Proceedings of the Conference on Maritime Meteorology held in London, 1874. 2*s.*
24. Instructions in the Use of Meteorological Instruments. [Reprinted 1888.] 2*s.* 6*d.*
25. Quarterly Weather Report for 1874.—Parts I., II., and IV. 5*s.* each. Part III., 5*s.* 9*d.*
26. Report for 1874. Presented to Parliament. 6*d.*

* The Meteorological Council have given away the copies which were placed at their disposal, but the work can be purchased from the Publishers.

LIST OF PUBLICATIONS, &c.—*continued.*

No. 27. Charts of Meteorological Data for the Nine 10° Squares of the Atlantic which lie between 20° N. and 10° S., and extend from 10° to 40° W., with accompanying Remarks, ending with the Best Routes across the Equator. 24*s*.

28. Contributions to our Knowledge of the Meteorology of Japan. By Staff-Commander Thomas H. Tizard, H.M.S. *Challenger*. 1*s*.

29. Report for 1875. Presented to Parliament. 4*d*.

30. Quarterly Weather Report for 1875.—Parts I.—IV. 5*s*. each.

31. Report for 1876–7. Presented to Parliament. 3*s*. 5*d*.

*32. A Discussion of the Meteorology of the North Atlantic during August 1873, with 31 Synoptic Charts. 15*s*.

33. Quarterly Weather Report for 1876 (New Series).—Part I., 6*s*.; Parts II., III., and IV., 5*s*. each.

*34. Contributions to our Knowledge of the Meteorology of the Arctic Regions. Vol. I.,—Part I., 2*s*.; Part II., 10*s*.; Part III., 6*s*.; Part IV., 5*s*.; Part V., 6*s*.

35. Report for 1877–8. Presented to Parliament. 1*s*.

36. Report of the Proceedings of the Meteorological Congress at Rome, 1879. 1*s*. 6*d*.

37. Report on the Meteorology of Kerguelen Island. By the Rev. S. J. Perry, S.J., F.R.S. 3*s*.

38. Report for 1878–9. Presented to Parliament. 5*d*.

39. Meteorological Observations at Stations of the Second Order for the year 1878. 20*s*.

40. Aids to the Study and Forecast of Weather, by the Rev. W. Clement Ley, M.A. 1*s*.

41. Report for 1879–80. Presented to Parliament. 1*s*.

42. Report for 1880–81. Presented to Parliament. 1*s*. 2*d*.

43. Charts of Meteorological Data for the Ocean District adjacent to the Cape of Good Hope, with accompanying Remarks. Price of the Charts, 25*s*.; of the Remarks, 7*s*.

44. Report on the Gales experienced in the Ocean District adjacent to the Cape of Good Hope, between Lat. 30° and 50° S., and Long. 10° and 40° E., by Capt. H. Toynbee. 7*s*. 6*d*.

45. Meteorological Observations at Stations of the Second Order for the year 1879. 20*s*.

46. Report on the Storm of October 13–14, 1881. By Robert H. Scott, F.R.S. 1*s*. 6*d*.

47. Rainfall Tables of the British Isles for 1866–80. Compiled by G. J. Symons, F.R.S. 7*s*. 6*d*.

48. Report for 1881–2. Presented to Parliament. 1*s*.

49. Quarterly Weather Report for 1879. (New Series.) Appendices and Plates. 27*s*. Parts I., II., and III., 6*s*. each. Part IV., 5*s*. 6*d*.

50. Quarterly Weather Report for 1880. (New Series.) Appendices and Plates. 28*s*. Parts I. and II., 6*s*. each. Part III. (In the Press.)

51. Hourly Readings, 1881. (New Series.) Part I., 10*s*. 6*d*. Parts II., III., and IV., 21*s*. each.

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* The Meteorological Council have given away the copies which were placed at their disposal, but the work can be purchased from the Publishers.

LIST OF PUBLICATIONS, &c.—*continued.*

No. 52. Quarterly Weather Report for 1877. (New Series.) Appendices and Plates. 27*s.*; Part I., 10*s.*; Part II., 5*s.* Part III., 4*s.* 6*d.*; Part IV., 6*s.*

53. Meteorological Atlas of the British Isles. 5*s.* 6*d.*

54. Hourly Readings, 1882. Parts I. and II., 20*s.* each. Part III., 22*s.* 6*d.* Part IV., 26*s.*

55. Quarterly Weather Report for 1878. (New Series.) Appendices and Plates. 28*s.*; Parts I., II., III., and IV., 6*s.* each.

56. Sunshine Records of the United Kingdom for 1881. 4*s.*

57. Meteorological Observations at Stations of the Second Order for the year 1880. 34*s.* 6*d.*

58. Report for 1882–3. Presented to Parliament. 10½*d.*

59. Sea Temperature Charts for the Atlantic, Pacific, and Indian Oceans. 21*s.*

60. Principles of Weather Forecasting. By the Hon. Ralph Abercromby, F.R.Met.Soc. (Second edition), 2*s.*

61. A Barometer Manual for the Use of Seamen. 1*s.* 3*d.*

62. Monthly Weather Reports for 1884. Jan., Feb., March, May —Nov., 1*s.* 6*d.* each. April (with 2 Appendices), 2*s.* 6*d.* Dec., 1*s.* 9*d.*

63. Hourly Readings, 1883. Parts I., II., and III., 21*s.* each. Part IV., 30*s.*

64. Report for 1883–4. Presented to Parliament. 1*s.* 2*d.*

65. Monthly Weather Reports for 1885. Jan. to Dec. 1*s.* 6*d.* each.

66. Meteorological Observations at Stations of the Second Order for the year 1881. 35*s.*

67. Report for 1884–5. Presented to Parliament. 4*s.* 4*d.*

68. Monthly Weather Reports for 1886. Jan. to Dec., 1*s.* 6*d.* each.

69. Meteorological Observations at Stations of the Second Order for the year 1882. 35*s.*

70. Hourly Readings, 1884. Part I., 12*s.*; Part II., 10*s.*; Part III., 10*s.* 6*d.*; Part IV., 15*s.*

71. Synchronous Weather Charts of the North Atlantic and the adjacent Continents. Aug. 1, 1882 to Sept. 3, 1883. Parts I. to IV. (33 sheets each.) 17*s.* each.

72. Report for 1885–86. Presented to Parliament. 8*d.*

73. Meteorological Observations at Stations of the Second Order for the year 1883. 30*s.*

74. Hourly Readings, 1885. Parts I. and II., 11*s.* each. Part III., 10*s.* 6*d.*; Part IV., 12*s.*

75. Report for 1886–87. Presented to Parliament. 8*d.*

76. Charts showing the Mean Barometric Pressure over the Atlantic, Indian, and Pacific Oceans. 10*s.* 6*d.* Supplemental Chart, 6*d.*

77. Monthly Weather Reports for 1887. January to August, 1*s.* 6*d.* each. September to December. (In the Press.)

78. Meteorological Observations at Stations of the Second Order for the year 1884. 32*s.*

79. Report for 1887–88. Presented to Parliament. 1*s.*

80. Daily Weather Charts of the Arabian Sea for the period of six weeks ending June 25, 1885 (The Aden Cyclone). (In the Press.)

LIST OF PUBLICATIONS, &c.—*continued.*

No. 81. Hourly Readings. 1886. Parts I., II., and III. 10*s.* 6*d.* each. Part IV. 12*s.* 6*d.*

82. Meteorological Observations at Stations of the Second Order for the year 1885. 31*s.*

83. Meteorological Observations at the Foreign and Colonial Stations of the Royal Engineers and Army Medical Department. 1852–1886. 23*s.*

84. Report for 1888–89. Presented to Parliament. 5½*d.*

*85. Weekly Weather Report for the year 1888. Vol. V. Second Series. 4*d.* per week. With Appendices and Monthly Supplements, priced separately.

86. Weekly Weather Report for the year 1889. Vol. VI. Second Series. 6*d.* per week. With Appendices and Supplements, priced separately.

87. Weekly Weather Report for 1890. Vol. VII. Third Series. 6*d.* per week. With Appendices and Monthly Supplements, priced separately.

88. Meteorological Observations at Stations of the Second Order for 1886. 25*s.*

89. Meteorological Observations made at Sanchez, Samaná Bay, St. Domingo. 1886–88. By the late W. Reid, M.D. 8*s.* 6*d.*

90. Cyclone Tracks in the South Indian Ocean. (In the Press.)

91. Report for 1889–90. 7½*d.*

92. Charts of Meteorological Data near Cape Guardafui. (In the Press.)

93. Harmonic Analysis of Hourly Observations of Air Temperature and Pressure at British Observatories. (In the Press.)

94. Hourly Readings. 1887. (In the Press.)

95. Meteorological Observations at Stations of the Second Order. 1887. (In the Press.)

NON-OFFICIAL.

No. 1. Report to the Committee on the Connexion between Strong Winds and Barometrical Differences.—By Robert H. Scott, Director of the Office. 6*d.*

†2. Report to the Committee on the Meteorology of the North Atlantic.—By Captain H. Toynbee, Marine Superintendent. 1*s.*

†3. Report to the Committee on the Use of Isobaric Curves.—By Captain H. Toynbee, Marine Superintendent. 1*s.*

4. Routes for Steamers from Aden to the Straits of Sunda and back. Translated from a Paper issued by the Royal Meteorological Institute of the Netherlands. 6*d.*

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* The publication of the Weekly Weather Report began in February 1878.

† The Meteorological Council have given away the copies which were placed at their disposal, but the work can be purchased from the Publishers.

LIST OF PUBLICATIONS, &c.—*continued.*

No. 5. On the Winds, &c. of the North Atlantic along the Tracks of Steamers from the Channel to New York. Translated from a Paper issued by the Deutsche Seewarte, Hamburg. 6*d.*

6. Report of the Proceedings of the Meteorological Conference at Leipzig. 1872. 1*s.*

7. Notes on the Form of Cyclones in the Southern Indian Ocean. — By C. Meldrum, M.A., F.R.S. [Out of Print.]

8. Report on Weather Telegraphy and Storm Warnings. Presented to the Meteorological Congress at Vienna. 1873. 6*d.*

9. Report of the Permanent Committee of the Vienna Congress for 1874. 1*s.* 6*d.*

10. On the Physical Geography of that part of the Atlantic which lies between 20° N. and 10° S. and extends from 10° to 40° W. A Paper read before the British Association at Bristol, in August 1875.—By Capt. Toynbee, F.R.A.S., F.R.G.S., Marine Superintendent. 1*s.* 6*d.*

11. Report of the Permanent Committee of the Vienna Congress for 1876. 2*s.*

12. Reports to the Permanent Committee of the Vienna Congress on Atmospheric Electricity, Maritime Meteorology, and Weather Telegraphy, 1878. 2*s.*

13. Report of the Permanent Committee of the Vienna Congress for 1878. 6*d.*

14. Report of the International Meteorological Committee Meeting at Berne, 1880. 1*s.*

15. Report of the Second Meeting of the International Meteorological Committee, held at Copenhagen, August 1882. 2*s.* 6*d.*

16. Report of the Third Meeting of the International Meteorological Committee, held at Paris, September 1885. 1*s.*

17. Report of the Fourth Meeting of the International Meteorological Committee held at Zürich, September 1888. 4*d.*

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For Her Majesty's Stationery Office.

REPORT

OF THE

METEOROLOGICAL COUNCIL

TO THE

ROYAL SOCIETY,

For the Year ending 31st of March 1891.

Presented to both Houses of Parliament by Command of Her Majesty.

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THE METEOROLOGICAL COUNCIL,

1890–91.

Lieutenant-General RICHARD STRACHEY, R.E., C.S.I., F.R.S., Chairman.

MR. ALEXANDER BUCHAN, M.A., LL.D., F.R.S.E.

Professor GEORGE HOWARD DARWIN, M.A., LL.D., F.R.S.

MR. FRANCIS GALTON, M.A., F.R.S.

MR. EDWARD J. STONE, M.A., F.R.S.

Captain WILLIAM J. L. WHARTON, R.N., F.R.S., Hydrographer of the Admiralty.

REPORT

OF THE

METEOROLOGICAL COUNCIL

TO THE

ROYAL SOCIETY,

For the Year ending March 31, 1891.

Introductory.

THERE has been no change in the Council during the year. The executive officers are as in the last Report:—

Mr. R. H. Scott, M.A., F.R.S., Secretary.
Nav.-Lieut. C. W. Baillie, R.N., F.R.A.S., Marine Superintendent.

Transfer of Valencia Observatory.

Purchase of new House for Valencia Observatory.—The Council, having come to the conclusion that it was desirable to transfer their observatory on Valencia Island to a house in the immediate neighbourhood in a more favourable situation, arranged, with the sanction of the Treasury and the assent of the Royal Society, to supply the necessary funds for the purchase of Westwood House, Cahirciveen, in the name of the President and Council of the Royal Society, the legal status of the Meteorological Council not admitting of their entering into a contract of this description. The particulars will be found in Appendix I., p. 23.

Registration of Council as a corporate body.

Registration under Companies Act.—In view of the difficulty that arose in the foregoing matter the Council further resolved to apply to the Board of Trade for registration under section 23 of the Companies Act, 1867, having first obtained the consent of the President and Council of the Royal Society to their action. The matter is now under the consideration of the Board of Trade.

Admission of Boy Clerks.—To regulate in a more satisfactory manner the admission of boy clerks to the Office, rules were framed on the subject during the past year, following as far as practicable the system followed in the Public Service. The rules will be found at Appendix II., p. 25.

The present Report is arranged under three headings:—

I. Ocean Meteorology.
II. Weather Telegraphy.
III. Land Meteorology of the British Isles.

PART I.

Ocean Meteorology.

Collection of information.

Collection of Information.—The practice followed by the Office with reference to observers at sea, as described in former Reports, remains unchanged.

Recognition of "excellent" observers.

Appendix III. (p. 26) contains a list of all the observers who during the past year have contributed logs classed as "excellent." Several of these observers have regularly co-operated with the Office for many years. The names which appear in the list for the first time are as follow:—

Captain's Name.	Ship.
George of Wales, H.R.H. Prince (Lieut. and Commr., K.G.).	H.M.S. "Thrush."
Andersen, O. E. - - -	S.S. "Longhirst."
Buckler, J. H. - - -	S.S. "Essequibo."
Day, Lieut. E. A., R.N. - -	H.M.S. "Dart."
Elliott, W., R.N.R. - - -	S.S. "Clan Murray."
Gilpin-Brown, Lieut. F. D., R.N. -	H.M.S. "Egeria."
Gould, H. W. - - -	S.S. "Norse King."
Home, W. E., R.N., M.B., B. Sc. -	H.M.S. "Thrush."
Nicholson, J. I. - - -	"Majestic."
Somerville, Lieut. Boyle, T. R.N. -	H.M.S. "Dart."
Squares, W. G., Chief Officer -	S.S. "Minia."
Speck, F. - - - -	S.S. "Rohilla."
Streater, R. - - - -	"Lutterworth."
Trenaman, R. W. - - -	S.S. "Pascal."
Young, W. H., Chief Officer - -	S.S. "Clan Murray."

Proportion of "excellent" to total number of logs received.

The total number of logs received in the year ending March 31, 1891, is 156, of which 115, or 74 per cent., have been classed as "excellent."

The average number of logs received annually during the five years, 1885–89, was 183, of which the per-centage of "excellent" logs was 75.

The Council take this opportunity of expressing their best thanks to the observers who have assisted them during the past year.

They regret to have to announce the deaths of two of their observers; Capt. W. Hird, ship "Marlborough," who had kept 6 "excellent" logs; and Capt. T. Mesnard, ship "Sierra Miranda," who had kept 9.

Appendix IV. (p. 28) gives a list of meteorological logs and of meteorological reports from stations abroad, received at the Office during the year.

The following summary of the voyages of the ships observing for the Office shows the districts from which observations were received during the year:— Districts from which observations are obtained.

To Baffin's Bay or Greenland	4
„ North America, East Coast	17
„ „ „ West „	3
Off East Coast of North America	3
To West Indies	16
„ South America, East Coast	19
„ „ „ West „	3
„ Australia and New Zealand, viâ Cape of Good Hope	23
At Australian stations	7
To India, viâ Suez	5
„ India, viâ Cape of Good Hope	22
„ China, viâ Suez	8
„ Cape of Good Hope	12
„ East Coast of Africa	1
Between British Ports	4
To Continental Ports	9

Red Sea Charts.—The printing of these charts has been delayed by the introduction of new matter relating to the distribution of gales. The charts are now almost completed. Red Sea.

Cape Guardafui Charts.—These charts have been engraved and published. Cape Guardafui.

The Aden Cyclone of June 1885.—These charts have been engraved and published. The Aden Cyclone.

Cyclone Tracks in the Southern Indian Ocean.—These have been engraved and published. Indian Ocean Cyclones.

Current Charts for the Atlantic, Pacific, and Indian Oceans.— The extraction of data from the Remark Books of the Royal Navy has been completed, and the Royal Navy log books are now being examined for the period prior to the introduction of the uniform system of Remark Books. Current Charts.

Southern Ocean.—The extraction of data from the Office logs for this district has been completed, and the log books of H. M. ships are now being dealt with. Southern Ocean.

Supply of Instruments to Stations in the Pacific, &c.—In further continuance of the endeavour to obtain information from the Pacific Islands and other rarely visited parts of the ocean, instruments have been supplied during the year to three stations in British New Guinea, to Fotuna Island, New Hebrides, and to Valua Island in the Banks Group, lying to the north of the last-named group. The Council also intend in the coming summer to supply a meteorological outfit, with a self-recording anemometer, to St. Helena. Pacific Ocean.

Heligoland.—The instruments belonging to the Office at Heligoland have been withdrawn, on the transfer of that island to Germany.

Stock of Instruments belonging to the Office.

Supply and Stock of Instruments.—In Appendix V. (p. 34) is given a list of the meteorological instruments supplied by the Office to ships in the Royal Navy during the year, with a statement for the 31st March 1891 of the stock and distribution of the instruments standing on the books to the account of the Admiralty.

Appendix VI. (p. 35) gives similar information with regard to the disposal of the other instruments belonging to the Office, remaining in store, or which have been supplied to the Mercantile Marine, observatories, telegraph offices, &c.

PART II.

Weather Telegraphy and Forecasts.

Administrative.

There have been no serious interruptions of telegraphic communication, and no changes in the reporting staff, during the year.

A list of the telegraphic reporting stations, British and Foreign, is given in Appendix VII. (p. 36).

The work in this branch of the Office continues to increase. The Daily and Weekly Weather Reports, in particular, have been extended and improved.

Inspection of the Stations.

Inspection of the Telegraphic Reporting Stations.—The telegraphic reporting stations have been inspected during the year, in England by Mr. Ley, in Scotland by Mr. Buchan, and in Ireland and Wales by Mr. Scott. The reports submitted by the Inspectors to the Council, which are printed in Appendix VIII. (p. 37), show that the efficiency of the service continues to be satisfactorily maintained.

Discussion of the reports.

Discussion and Publication of the Information received.—The practice of the Office in collecting, discussing, and disseminating the meteorological information received by telegraph is described in Appendix IX. (p. 55). The Daily Weather Report has appeared regularly during the year; for details see that Appendix. It is distributed free of cost as follows:—To newspapers, seven copies; to seaports, for public exhibition, 71 copies; to Government offices and public institutions, 66 copies; to correspondents of the Office, 73 copies; and to foreign meteorological establishments, 46 copies. Nearly 200 copies are issued regularly to subscribers.

The Weekly Weather Report, with its Monthly Appendices, has also appeared regularly; for particulars of this publication see Appendix IX., p. 56.

Display of information in front of the Office.

Public display at the Office of the State of the Weather on British Coasts.—With a view to the earliest possible supply to the public of the latest information as to the weather received from the principal points on the southern coasts, the substance of the reports received by telegraph at 9.30 a.m. and 3 p.m. every week day, of the state of the weather and sea at the following stations: Yarmouth, Dungeness, the Needles (Hurst Castle), Scilly, Holyhead, and Valencia, is displayed in a conspicuous manner on the front of the Office, 63, Victoria Street.

Weather Forecasts.—Forecasts are prepared three times a day, namely, at 11 a.m., at 3.30 p.m., and 8.30 p.m. The Forecasts prepared at 11 a.m., on the information derived from the 8 a.m. reports, refer to the probable weather between noon on the day of issue and noon on the following day. They are publicly exhibited in several places in London,* and are supplied to the afternoon editions of the newspapers. The 3.30 p.m. Forecasts are employed for storm warnings only, excepting in the hay harvest season, when they are issued, as subsequently explained. The forecasts at 8.30 p.m. are specially prepared for publication in the morning newspapers, but all the forecasts are available for the information of anyone who applies for them at the Office. Forecasts.

The inquiries received through the Post Office for special forecasts during the year amounted to 58, and the personal applications to 45. The rules of the Office relating to such inquiries are stated in Appendix IX. (p. 60). Inquiries at the Office.

The results of a comparison of the Forecasts issued at 8.30 p.m during the year, with the weather actually experienced are given in Appendix X. (p. 62). The following summary shows the successes and failures over the whole United Kingdom, estimated as explained in that Appendix. The results were best, 88 per cent., for England South, and worst, 77 per cent., for Ireland South. Results of Forecasts.

SUMMARY of RESULTS of 8.30 p.m. FORECASTS, 1890–91.

Districts.	Per-centages.				Total per-centage of Success.
	Complete Success.	Partial* Success.	Partial* Failure.	Total Failure.	
SCOTLAND, N. - -	48	35	11	6	83
„ E. - -	53	27	13	7	80
ENGLAND, N.E. - -	54	29	12	6	83
„ E. - -	53	30	13	5	83
MIDLAND COUNTIES -	53	30	13	4	83
ENGLAND, S. - -	58	30	10	3	88
SCOTLAND, W. - -	46	33	14	8	79
ENGLAND, N.W. -	49	34	11	6	83
„ S.W. -	52	31	11	7	83
IRELAND, N. - -	45	34	12	9	79
„ S. - -	42	35	14	10	77
Summary - -	50	32	12	6	82

* Note "partial" implies "more than half."

* Viz., in the City, at the Mansion House, Lloyd's Rooms, Messrs. R. & J. Beck's, Cornhill, and Messrs. de la Rue & Co.'s, Bunhill Row; in the West End, in the Libraries of the House of Lords and House of Commons, at Messrs. Elliot's, St. Martin's Lane; Messrs. Stanford's, Charing Cross; Messrs. Negretti & Zambra's, Regent Street; and Messrs. Pastorelli's, New Bond Street; and at the Office, 63, Victoria Street.

Testing of the Forecasts.

The following table shows for each year from 1882 to 1890, inclusive, the per-centages of complete and partial success of the Forecasts issued at 8.30 p.m. for the whole year.

PER-CENTAGES of RESULTS of FORECASTS for the whole of the BRITISH ISLES.

Year.	Complete Success.	Partial, *i.e.*, more than Half Success.	Total Success.
1882 - -	43	37	80
1883 - -	48	33	81
1884 - -	50	31	81
1885 - -	50	34	84
1886 - -	49	31	80
1887 - -	52	32	84
1888 - -	51	31	82
1889 - -	49	32	81
1890 - -	50	32	82
Average - -	49	32	81

Hay Harvest Forecasts.

Hay Harvest Forecasts.—The Council renewed in 1890 the offer made in previous years to the Royal Agricultural Society, the Royal Dublin Society, and the Highland and Agricultural Society to send Daily Forecasts *gratis* during the haymaking season to a number of observers selected by those Societies, on two conditions, viz., that the information should be made known as widely as possible, and a record of the weather actually experienced sent weekly to the Office. The Societies accepted the proposal, and the Forecasts were issued as shown in the following table:—

LIST of those who received HAY HARVEST FORECASTS in 1890.

Districts.	To whom sent.	Address.
0. SCOTLAND, N.	Rev. Dr. Joass -	Golspie.
	Major Smith - -	Munlochy, Inverness.
1. SCOTLAND, E.	J. Whitton - -	Glamis Castle, by Forfar.
	G. Murdoch - -	Rothiemay, Huntly.
	C. L. W. Forbes -	Aberfeldy.
2. ENGLAND, N.E.	Sir J. Wilson - -	Chillingham Barns, Chatton, Northumberland.
	J. Turner - -	The Grange, Ulceby.
3. ENGLAND, E.	W. Birkbeck - -	High House, Thorpe, Norwich.
	Sir J. B. Lawes, Bt., and J. H. Gilbert, Ph.D.	Rothamsted, Harpenden.
4. MIDLAND COUNTIES	Royal Agricultural College.	Cirencester.
	E. E. Harcourt-Vernon	Grove Hall, East Retford.
5. ENGLAND, S.	C. Whitehead - -	Barming House, Maidstone.
	E. P. Squarey -	The Moot, Downton, Wilts.
	G. M. Allender -	Stammerham, Horsham.
	M. J. Sutton - -	Reading.

Hay Harvest Forecasts.

Districts.	To whom sent.	Address.
6. Scotland, W.	W. Calder	Castle Hill, Dalreoch, Dumbarton.
	M. J. Stewart, M.P.	Ardwell, Stranraer.
	J. S. R. Ballingal	Eallabus House, Islay.
7. England, N.W.	G. W. Wray	Leyburn, Yorkshire.
	The Earl of Derby, K.G.	Knowsley Hall, Prescot.
8. England, S.W.	Colonel T. Picton Turbervill.	Ewenny Priory, Bridgend, Glamorganshire.
	The Earl of Ducie	Tortworth, Gloucestershire.
	T. Dyke	Long Ashton, Clifton, Bristol.
	R. Neville Grenville	Butleigh Court, Glastonbury.
9. Ireland, N.	E. F. Farrell	Moynalty, Co. Meath.
	J. M. Wilson, J.P.	Currygrane, Edgeworthstown.
10. Ireland, S.	D. A. Milward	Lavistown, Kilkenny.
	W. Talbot Crosbie, D.L.	Ardfert Abbey, Tralee, Co. Kerry.
	The Earl of Rosse, K.P.	Birr Castle, Parsonstown.

The issue of the forecasts commenced on June 11th with those for the South and East of England, and were continued for about five weeks, ending on the 3rd of August over the greater part of Scotland, and a week later in Ireland.

The general result of the issue of these forecasts, shown by the subjoined table, has been prepared solely from the reports of the above-mentioned gentlemen, and is entirely independent of any estimate formed within the Office itself:—

Summary of Results.—Hay Harvest Forecasts, 1890.

Districts.	Names of Stations.	Percentages. Complete Success.	Partial Success.	Partial Failure.	Total Failure.	Total percentage of Success.
Scotland, N.	Munlochy and Golspie	52	35	8	5	87
„ E.	Aberfeldy, Glamis, and Rothiemay	53	42	5	—	95
England, N.E.	Chatton and Ulceby	57	31	10	2	88
„ E.	Rothamsted, and Thorpe	54	32	13	1	86
Midland Counties	Cirencester and East Retford	50	42	6	2	92
England, S.	Reading, Maidstone, Downton, and Horsham.	52	42	6	—	94
Scotland, W.	Stranraer, Islay, and Dumbarton	60	28	12	—	88
England, N.W.	Leyburn and Prescot	47	38	12	3	85
„ S.W.	Tortworth, Clifton, Bridgend, and Glastonbury.	52	36	11	1	88
Ireland, N.	Moynalty and Edgeworthstown	55	37	5	3	92
„ S.	Tralee, Kilkenny, and Parsonstown	50	37	9	4	87
	Mean for all districts	53	36	9	2	89

These figures show that the results for the forecasts for 1890 were about the same as those for 1889, and indicate the highest proportion of success that has ever been reached.

Hay Harvest Forecasts.

The largest general per-centage (95) was attained in the east of Scotland, and the lowest (85) was in England North-west.

A further reference was made to the Board of Agriculture on the subject of the possible extended utilization of these forecasts in agricultural districts, in pursuance of the intention noted in last year's Report.

Supply of Forecasts to the Fleet during the Manœuvres.—At the request of the Admiralty daily forecasts were supplied to the Commander-in-Chief of the "A" Fleet during the continuance of the Manœuvres as in the two preceding years.

Storm warnings.

Storm Warnings for the Coasts of the United Kingdom.—In Appendix XI. (p. 63) are given the names of the stations furnished with signals for Storm Warnings, in accordance with Circular 717 of the Board of Trade issued in February 1874.

These stations were, at the end of March 1891, 153 in number, situated:—

72 in England, 16 in Wales, 44 in Scotland, 15 in Ireland, 3 in the Isle of Man, and 3 in the Channel Islands.

A comparison has been made in the Office between the warnings issued during the year and the weather experienced on our coasts, the warnings being tested by the method explained in Appendix IX. (p. 60). The results of this comparison are shown in the following tables:—

RETURN of the RESULT of the COMPARISON between the WARNINGS ISSUED and the WEATHER EXPERIENCED in 1890.

Coasts.	Total No. of Orders to hoist and repetitions.	Warnings justified by subsequent Gales, Force 8 and upwards.	Warnings justified by subsequent strong Winds, Forces 6 and 7.	Warnings not justified by subsequent Weather.	Warnings late. Force 9 reached at two Stations before issue.	Warnings partially late. Force 9 reached at one Station before issue.	Storms for which no Warning was issued.
Scotland, N.E. -	40	32	6	2	—	—	Mar. 12,* Ap. 8, June 25.
„ E. -	32	17	11	3	—	1	—
„ N.W. -	44	26	13	2	1	2	June 25.
„ W. -	45	24	13	7	—	1	—
Ireland, S.W. -	53	34	8	8	1	2	Nov. 14.
„ N.W. -	49	32	10	2	3	2	Jan. 14, Mar. 12, Mar. 24, Ap. 9, Nov. 4, Dec. 31.
Irish Sea - -	46	34	4	4	—	4	Jan. 7, Ap. 8, Nov. 14, Dec. 30.
St. George's Channel	40	21	13	6	—	—	—
Bristol Channel -	39	23	14	1	—	1	Dec. 30.
England, S.W. -	35	21	12	1	—	1	Jan. 17.
„ S. -	26	15	9	2	—	—	—
„ S.E. -	23	12	9	2	—	—	—
„ E. -	24	11	9	3	1	—	—
„ N.E. -	29	18	3	6	1	1	Jan. 9, Mar. 12, Ap. 8.
Totals - -	525	320	134	49	7	15	
Per-centages -	—	61·0	25·5	9·3	1·3	2·9	

* This gale was confined to the extreme northern part of the district.

With a view of adding to the efficiency of these warnings a revision of the districts in which the stations are arranged has been made during the year, and further measures taken to improve the record of storms on the coasts by means of which the utility of the warnings are better checked than was formerly the case. Storm warnings.

Notes as to Gales in 1890 for which Warnings were not issued.

Gales, for which no warning was issued, were experienced on 11 occasions. They were in almost all instances confined to very limited portions of the coast, and may be grouped as follows :—

Three (on January 14th, March 24th, and November 4th) were felt in "Ireland, N.W." only. This is the first year in which any attempt has been made to warn this coast at all, as its very exposed position makes it liable to be affected by gales which arise from causes too far distant to be detected by the instruments in our islands in time for warnings to be issued.

One (January 7th) was of a sporadic character—only a few of the stations in the district (the Irish Sea) feeling any gale at all.

Three (January 9th, 17th, and December 30th–31st) resulted from the unexpected extension to an unwarned portion of the coast of gales which had been duly warned for in the other districts where they were felt.

Two (April 8th–9th and November 4th) were caused by a very sudden increase of pressure in the rear of disturbances which appeared to be passing away as unimportant systems.

Those needing special remark were the gales of—

March 12.—A fresh to strong gale from south-west and west felt over the northern parts of the kingdom. Its approach was not indicated by the Reports of March 11th.

June 25th.—Severe south-westerly to westerly gale in Scotland —caused by a depression which was either (1) much deeper on evening of 24th than appeared from the telegraphic reports, or (2) increased greatly in intensity as its centre advanced towards Scotland.

November 14.—Fresh to strong southerly to south-easterly gale felt over "Ireland, S.W." and the Irish Sea. No indication of its approach was given by the reports of the 13th.

December 30th–31st.—An easterly gale felt in the Bristol Channel and Irish Sea. Caused by the advance of a depression to Spain while an anticyclone of great intensity lay over the North Sea and south of Scandinavia. Our southern, eastern, and north-eastern coasts were warned, but the Bristol Channel and Irish Sea did not seem to be threatened.

Comparison of results for 1889 with previous years.

The following table contains a comparative statement of the storm warnings and their results in 1890, and in the ten preceding years. It will be seen that the total per-centage of warnings justified is 86·5, being 5·3 per cent. more than that for the preceding year:—

Years.	Total No. of Warnings issued.	Warnings justified by subsequent Gales.	Warnings justified by subsequent strong Winds.	Total Warnings justified.	Warnings not justified by subsequent Weather.
		p.c.	p.c.	p.c.	p.c.
1880	390	58·2	24·6	82·8	13·3
1881	454	58·6	23·3	81·9	14·8
1882	503	61·4	21·1	82·5	14·9
1883	610	56·2	21·6	77·8	20·8
1884	461	66·4	20·0	86·4	12·1
1885	591	55·3	24·0	79·3	19·5
1886	542	55·3	26·9	82·2	15·9
1887	472	55·5	26·1	81·6	16·4
1888	539	55·3	28·6	83·9	14·3
1889	373	47·7	33·5	81·2	16·9
1890	525	61·0	25·5	86·5	9·3

Fishery barometers.

Fishery Barometers.—To add to the means of obtaining warnings of stormy weather by the sea-going population, barometers were many years ago supplied by the Board of Trade on loan to fishing villages and other places on the coast, to be set up for public information. The whole number of stations supplied by the Office with these instruments is 180. Of these 58 are in England, 6 in Wales, 51 in Ireland, 60 in Scotland, 4 in the Isle of Man, and 1 in Jersey. The list is given in Appendix XII., p. 65.

The inspection of the Fishery Barometers in England and Ireland, which was commenced two years ago, has been completed by Captain Toynbee during the past summer.

In almost all cases the instruments were found to be in good order, and they seemed to be valued by the fishermen. Whenever possible, the opportunity of the inspection was taken to impart instruction in the use of instruments in connexion with weather observations.

Simultaneous observations.

Simultaneous Observations.—The Office has continued its co-operation in the system of International simultaneous observations, taken at Greenwich mean noon, as explained in former Reports, which was organised in 1874, at the request of the Chief Signal Officer of the United States.

The number of these observations which have been received during the year from the Royal Navy has been 4,000, and from the Mercantile Marine, 3,820.

PART III.

Land Meteorology of the British Isles.

Observatories and Stations.—The observations of the climate of the British Isles, which are received by the Office from certain

stations, may be arranged in five classes, according to the degree of completeness with which they are made.

Self-recording observatories.

1. The Observatories furnished with self-registering instruments by which all the principal meteorological phenomena are recorded continuously. These alone afford the materials necessary for the study of the periodic variations of the meteorological elements.

Anemographic stations.

2. Anemographic stations furnished with instruments registering the wind only. The records from these stations relate rather to weather as distinguished from climate, and are especially important in connexion with storms. They are often useful in affording evidence available in courts of law with respect to collisions at sea, and damage done by wind.

Stations of Second Order.

3. Stations of the Second Order furnishing climatological information from eye observations taken twice a day. The observers at these stations are all volunteers.

Telegraphic Reporting Stations.

4. The Telegraphic Reporting Stations, at which the observations are taken by eye, but supplemented in some cases by self-recording aneroids, &c., supply the material upon which the daily weather reports and forecasts are based. The hours of observation at these stations are determined by the requirements of the telegraphic system, as explained in Part II., but the data which they furnish are also utilized to afford climatological information for parts of the country where Stations of the Second Order do not exist.

Extra stations.

5. Extra stations furnishing returns with less completeness and detail than those of Class 3.

Sunshine stations.

A continuous record of the amount of bright sunshine is received from 42 stations in the British Isles, of which some are first or second order stations, whilst from others the sunshine record is alone received. See Appendix XIII., p. 66.

A fuller account of these several stations and of the methods employed by the Office in dealing with their records will be found in Appendix XIV., p. 67.

Documents received.

Appendix XV., p. 70, contains a list of all documents relating to the land meteorology of the British Isles received at the Office during the year.

Inspection of stations.

Inspection of the Stations.—The self-recording observatories and the anemographic stations (Classes 1 and 2), as well as the Telegraphic Reporting Stations (Class 4), are regularly visited each year by the Inspectors of the Office. The extra stations (Class 5) are inspected as opportunity offers. Of the Stations of the Second Order (Class 3), some belong to the Royal Meteorological Society, and these are visited by an Inspector appointed by that Society, an allowance being made by the Office toward the cost of the inspection, in accordance with the recommendation of the Treasury Committee (1877). The remaining Stations of the Second Order, including those belonging to the Scottish Meteorological Society, are visited most of them annually by the Inspectors of the Office. The Superintendent of the Kew Observatory, Mr. G. M. Whipple, and his chief assistant, Mr. T. W. Baker, are specially employed to inspect and report on the self-registering apparatus, and on the

Inspection of stations.

photographic processes at the observatories. Extracts from the Reports of the Inspectors are given in Appendix VIII., p. 37.

Reports supplied to Registrar General for Ireland.

Information supplied to the General Register Office, Dublin.—Reports from eleven of the Irish stations of the Office have been regularly supplied to the Registrar General for Ireland, for his Weekly and Quarterly Returns.

Publications.

The Quarterly Weather Report.—The volume for 1880 has been completed, and with it the issue of these Reports, with the reproduction of the continuous records from the seven observatories, comes to an end. A list of the volumes of this publication, with the dates of their several appearances, was given in the last Report. In its place there have been successively issued, first, the Monthly Weather Report for the years 1884 to 1887, and subsequently the Monthly Summary of the Weekly Weather Report. It is intended to publish a quarterly summary of the principal weather changes for the years 1881 to 1883, so as to connect the Quarterly Weather Reports with the Monthly Weather Report series.

The Weekly Weather Report, which is prepared in the Telegraphic Branch of the Office (see Appendix IX., p. 56), supplies, by its synchronous charts and Monthly Summaries, a very complete and instructive view of the chief meteorological changes, day by day, over the greater part of Europe, such as is not to be found in any of the similar publications issued by any other office.

Appendix I. to the Weekly Weather Report for 1890 gives a summary for each quarter, and for the whole year, of the Rainfall and Temperature for each district, for the 25 years 1866–1890, and also the Monthly and Progressive values of Accumulated Heat, Rainfall, and Bright Sunshine for all the districts in each month of 1890. Appendix II. to the same Report gives the Weekly and Progressive values for the same elements during the year 1890 (in continuation of Appendix II. for the year 1889), and Appendix III. gives the Mean Weekly values for the following number of years:—

Accumulated Heat and Rainfall, 13 years, 1878 to 1890.
Bright Sunshine - - 10 „ 1881 „ 1890.

Appendix IV. gives for each district, for the 13 years 1878 to 1890, the mean temperature for each week in the year.

Hourly Readings of Meteorological Instruments.—The Volume of Hourly Means for 1887, which, as was announced in the last Annual Report, the Council have determined to substitute for the Hourly Readings hitherto published, has been issued. It comprises:—

(1.) *Hourly* means of pressure, temperature, the difference between the dry and wet bulbs, and of wind components, together with the amount and frequency of rain; these hourly means will be for periods of (*a*) five days, (*b*) calendar months, and (*c*) the year.

(2.) The daily, five-daily, monthly, and yearly means of pressure and temperature, and amounts of rainfall. Publications.

(3.) The daily extremes of pressure and temperature, and the maximum hourly fall of rain in each month.

(4.) The number of observations of wind and the mean velocity, referred to eight points, for each hour of the day and for the day, for each month; and also the mean velocity of the wind, irrespective of direction, at each hour of the day for each month.

The computation of mean hourly values of the temperature of the air and of barometrical pressure for the seven observatories and for each month has been completed for several years, and is still being carried on. The work is somewhat lengthy, but considerable progress has already been made with it.

Observations at Stations of the Second Order.—The volumes for 1886 and 1887 have appeared.

As mentioned in the last Report, the number of stations returns from which are published *in extenso* has been reduced to 21, while at the same time the number of those from which monthly means and summaries are published has been largely increased.

The following is the list of stations for which returns have been published for 1887 :—

STATIONS for PUBLICATION in DETAIL on Form A., 21 in Number.

Stations.	In connexion with	Years already published in detail.	Remarks.
Glasgow - -	M. O.	11	Formerly observatories. 10 years hourly readings already published.
Stonyhurst -	M. O.	13	Continuous records of pressure, temperature, wind, and rainfall still available, except for Armagh, which furnishes wind and rain only. For Stonyhurst and Armagh the records for 1884 and 1885 have been published among the stations on Form A.
Armagh - -	M. O.	13	
Dunrobin Castle -	S. Met. Soc.	7	
Braemar - -	S. Met. Soc.	7	High-level station (1,113 feet).
Dundee - -	S. Met. Soc.	7	
Wolfelee - -	S. Met. Soc.	1	
Scarborough -	R. Met. Soc.	6	
Hillington -	R. Met. Soc.	10	
Churchstoke -	R. Met. Soc.	11	Sutton Coldfield to be substituted for Churchstoke for 1889.
Carmarthen -	R. Met. Soc.	12	
Margate - -	R. Met. Soc.	5	
Babbacombe -	R. Met. Soc.	10	Dartmoor (1,395 feet) to be substituted for Babbacombe in 1890.
Swanbister (Orkneys).	M. O.	1	This is the most northern station available, and there is a continuous record of wind.

Publications.

Stations.	In connexion with	Years already published in detail.	Remarks.
Laudale - -	M. O.	8	
Douglas (Isle of Man).	M. O.	9	
Southampton -	M. O.	9	At both of these stations there are long series of observations available taken by the officers of the Ordnance Survey.
Dublin (Mountjoy Observatory).	M. O.	1	
Markree Castle -	M. O.	12	
Parsonstown -	M. O.	14	
Londonderry -	M. O.	8	

List for Publication on Form B. (Monthly Means and Summaries).

Swanbister.
Ⓢ Lairg.
Ⓢ Dunrobin Castle.
Ⓢ Gordon Castle.
Ⓢ Glencarron.
Aberdeen.
Ⓢ Fort Augustus.
Ⓢ Braemar.
Ⓢ Fort William.
Ⓢ Lednathie.
Laudale (Argyleshire).
Ⓢ Dundee.
Ⓢ Ochtertyre.
Ⓢ Callton Mor.
Glasgow.
Ⓢ Rosewell.
Ⓢ Rothesay (Isle of Bute).
Ⓢ Marchmont.
Ⓢ Wolfelee.
Ⓢ Pinmore (Ayrshire).
Ⓢ Glenlee.
Ⓡ Cramlington.
Ⓢ Cargen.
Durham.
Newton Reigny.
Aysgarth (Yorkshire).
Ⓡ Scarborough.
Cronkbourne (Douglas), Isle of Man.
York.
Stonyhurst.
Ⓡ Wakefield.
Prestwich.
Ⓡ Llandudno.
Ⓡ Buxton.
Ⓡ Cheadle.
Ⓡ Hillington (Norfolk).
Leicester.
Uppingham.
Ⓡ Churchstoke (Montgomeryshire).
Geldeston (Beccles).
Ⓡ Bennington.
Ⓡ Cheltenham.
St. David's.
Ⓡ Carmarthen.
Ⓡ Berkhamsted.
Kew.
Ⓡ Margate.
Southampton (Ord. Survey Office).
St. Leonard's.
Eastbourne.
Ⓡ Southbourne.
Ⓡ Rousdon.
Ⓡ Dartmoor.
Ⓡ Babbacombe (Torquay).
Falmouth.
Londonderry.
Ⓢ Lissan (Co. Tyrone).
Armagh.
Brookeborough (Colebrooke Park).
Markree Castle (Co. Sligo).
Dublin (Glasnevin).
Dublin (Mountjoy Observatory, Phœnix Park).
Dublin (City).
Parsonstown (Birr Castle).
Ⓡ Killarney.
Valencia.

The Stations marked Ⓢ belong to the Scottish, and those marked Ⓡ to the Royal Meteorological Society.

Observations on Ben Nevis.

Observations on Ben Nevis.—The arrangements made with the Directors of the Observatory on the summit of Ben Nevis, at a height of 4,406 feet above the sea, and explained in the Report for 1885, remain in force, and the Council have continued the annual grant of 100*l.* towards the expenses of the Observatory,

and have received MS. copies of all the meteorological observations taken. Observations on Ben Nevis.

The building of the new observatory at Fort William, which has been constructed in connexion with that on Ben Nevis, is now completed. It has previously been explained that the Council had agreed to subsidize this observatory to the extent of 250*l.* a year, and supply it with the necessary outfit of instruments. These were sent down and erected in July 1890, and the observations began on July 14. Observatory at Fort William.

Removal of the Anemometer from Swanbister, Orkney.—In the month of August the anemometer which had been situated at Swanbister, in the parish of Orphir, Orkney, since the death of Dr. Clouston, of Sandwick, was removed to Stenness schoolhouse. The change was rendered necessary by the removal of Mr. Fortescue from Swanbister. Mr. Whipple superintended the operations. Change of position of station in the Orkney Islands.

Sea Surface Temperature on the Coasts of the British Isles.—These observations, which are obtained through the courteous assistance of the Admiral Superintendent of Naval Reserves, the Trinity House, and the Commissioners of Irish Lights, are still continued, and a large amount of valuable information is thereby collected. Sea Surface Temperature.

Cloud Photography and Measurement.—This subject has continued to receive attention, but as yet thoroughly satisfactory results have not been obtained. Cloud Photography.

The methods formerly adopted for this work have been considerably modified, and the present arrangements are still of a somewhat tentative character; but it is hoped that results will eventually be obtained under the improved system, by means of which the difficulties of observation and computation hitherto met with will be overcome, and a practical method arrived at which will enable the height and velocity of clouds to be readily ascertained by the comparison of photographs made simultaneously at the extremities of a base of known length.

The Bridled Anemometer.—This instrument, devised by Professor Stokes for recording the force of strong gusts of wind, has been altered in accordance with the conclusions arrived at from the experiments carried out by Mr. W. H. Dines mentioned in the last Report, and further experiments have since been made by him in order to determine the scale of the instrument. Further experiments have also been carried on by Mr. Dines at Hersham with respect to other questions relating to wind from which many very interesting results are anticipated. An account of these will be found at Note A., p. 22. The Bridled Anemometer.

Electrical Anemometer.—The electrical recording anemometer, that had been removed from Valencia on account of the continued irregularities in its action, which it had not been found possible to Electrical Anemometer.

remedy, was erected at Kew for a fresh trial, after careful cleaning and the adoption of further modifications of parts of the mechanism in the hope of removing the defects in the operation of the apparatus. A prolonged trial and comparison of the records with the self-recording anemometer of the usual construction having conclusively shown that the electrical arrangement could not be relied on, the instrument was dismounted in July last, and it is not intended to persevere further with the experiment.

Violle's Actinometer.

Violle's Actinometers.—At the request of the Solar Physics Committee the Council have undertaken to institute some experiments at Kew Observatory on Violle's apparatus for measuring solar radiation. A series of observations have been made with two Violle's actinometers (boules conjuguées) in order to ascertain whether these instruments can be relied on to afford trustworthy and comparable measures of isolation, and also whether they are suited for the use of observers who have had no special training in the use of physical apparatus. After the thermometers had been verified, and the constants of the instruments, viz., their masses, dimensions, and respective rates of cooling, had been determined, they were subjected to a prolonged comparison, exposed to the sun under constant conditions. Subsequently several special series of observations were made with variations of the blackened surface, and with changes in the position of the instruments, in order to ascertain in what degree their indications are affected by such changes. The results have been communicated to the Committee on Solar Physics, and are now under discussion.

Trevandrum observations.

The negotiations mentioned in the last Report with regard to the discussion and publication of the meteorological and magnetic observations made by the late J. Allan Broun, F.R.S., in the years 1853 to 1865, at Trevandrum and Agustia in Southern India have been continued, with the result that the Indian Meteorological Department has agreed to undertake the work as far as regards the meteorological data. The whole of the records have accordingly been despatched to India, except those relating exclusively to magnetical work.

Library.

Library.

The library contains standard works on Meteorology and the allied Sciences, and is, besides, particularly rich in Transactions, Proceedings, Reports, and other Publications which give a large mass of Meteorological observational data from all parts of the world, extending over many years. It consists at present of over 11,000 volumes and pamphlets, exclusive of charts and MS. records of observations. The books and other documents are accessible to scientific men for reference at the Office.

Appendix XVI., p. 75, contains a list of the additions to the library during the year, which have been catalogued upon cards, and are entered in the reference catalogues under (1) Authors, and (2) Subjects.

Expenditure.

Financial.

Appendix XVII., p. 96, shows the receipts and payments during the year ending 31st March 1890. The amount voted by Parliament was 15,300*l.*, as in the previous year.

The following abstract of expenditure shows the amount properly chargeable to the year in question, and its distribution under the various heads, together with the increase or decrease in 1890–91 as compared with the previous year:

Net Expenditure.	1889–90.	1890–91.	Increase.	Decrease.
General Administration:	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Payment of Council -	955 18 4	988 15 0	32 16 8	—
Secretary - -	800 0 0	800 0 0	—	—
Office - - -	801 4 2	789 14 0	—	11 10 2
Rent, fuel, and lighting -	701 14 3	726 10 3	24 16 0	—
Alterations to premises, attendance, and contingencies - -	474 7 6	736 16 2	263 8 8	—
Expenses incidental to International Meteorological Congress -	5 2 0	37 9 8	32 7 8	—
Pensions - -	186 16 4	186 16 4	—	—
Special Researches -	710 10 6	950 13 3	240 2 9	—
Land Meteorology -	3,544 9 11	3,412 10 0	—	131 19 11
Weather Information -	3,777 19 5	3,759 17 11	—	18 1 6
Inspections - -	664 2 5	706 8 9	42 6 4	—
Ocean Meteorology -	2,736 9 4	2,294 5 2	—	442 4 2
Total - - £	15,358 14 2	15,390 16 6	635 18 1	603 15 9

In the year 1890–91 the sum of 1,515*l.* 10*s.* 8*d.* was paid to the Post Office on account of inland and foreign telegrams, allowances to clerks, and rental of private wires.

(Signed) R. Strachey,
Chairman.

NOTE A.

In the Report of 1890 it was stated that Mr. Dines was carrying out a series of experiments on the resistance of plates of various forms at oblique incidences to the wind. These experiments were carried out with skill and care, and the results have been communicated to the Royal Society in a valuable paper.* It is unnecessary to give an account here of the experiments, and it will suffice to say that the conclusions arrived at are interesting and novel, so that the Council feel that their support of the investigation has been fully justified.

On the suggestion of the Royal Meteorological Society, the Council requested Mr. Dines to carry out on their behalf a series of experiments for the purpose of comparing various forms of anemometer under the action of the natural wind. He hopes ultimately to make comparisons between—

1. A medium-sized Robinson anemometer.
2. A small Robinson anemometer.
3. Richard Frères anemometer.
4. Dines's self-adjusting helicoidal instrument.
5. A circular-pressure plate.
7. Sir G. Stokes's bridled anemometer.
8. An air-meter.

When the experiments are completed, a final report on all these instruments will be submitted to the Council.

For the present it will suffice to say that experiments were made on December 30th, 1890, for comparing the Kew pattern Robinson anemometer (with factor 2·00), an air-meter, and a tube anemometer. The constants of the air meter had been carefully determined by means of a series of experiments with the whirling machine. The tube anemometer was a combination of Lind's and Hagemann's instruments. The instruments were kept in action during about 25 minutes, with the result that the mean velocity of wind deduced from—

1. The Kew instrument, was 14·50 miles an hour.
2. The air-meter, was 15·62 miles an hour.
3. The tube anemometer, was 16·5 miles an hour.

Mr. Dines has also been making some supplementary experiments with his whirling machine on the resistances of curved plates and vanes. The work is nearly finished, and his report will be communicated to the Royal Society.

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* "On Wind Pressure on an inclined Surface," by W. H. Dines, *Proc. Roy. Soc.*, vol. xlviii., pp. 233–257.

APPENDIX.

APPENDIX I.

CORRESPONDENCE with the ROYAL SOCIETY as to PURCHASE of the LEASE of a HOUSE for the VALENCIA OBSERVATORY.

Meteorological Office,
January 12, 1891.

SIR,

I AM directed by the Meteorological Council to forward, for the consideration of the President and Council of the Royal Society, copies of letters* that have passed between the Meteorological Office and the Treasury relative to the proposed purchase of the lease of a house at Valencia, in Ireland, for an observatory in place of the present building now so used.

The Meteorological Council being satisfied that, so long as the meteorological services at present conducted under their supervision are maintained, an observatory at Valencia will be necessary, have been led to the conclusion that it is very desirable to take advantage of an opportunity that has now presented itself of securing, for what may be practically regarded as a permanency, a building much more conveniently situated and otherwise more suitable than the house now occupied for this purpose.

The constitution of the Meteorological Council and their dependence on the annual Parliamentary grant would make it impossible for them to enter into an agreement such as is involved in the purchase of a lease for a long term of years; and it has occurred to them that the object they have in view might be easily attained if the Royal Society would agree to become the purchasers of the lease, the purchase money and ground rent, together with all other liabilities, being at the entire charge of the Meteorological Office.

The Meteorological Council have at their command a sufficient sum to purchase the lease, viz., 1,400*l.*, and they can without any difficulty meet all other charges that may arise in connexion with the transaction.

They considered it to be essential to solicit the approval of the Treasury to the arrangement before addressing the Royal Society, and they have now obtained this necessary authority, and have also been informed that the representatives of the present leaseholders are prepared to sell for the sum already named.

Together with the letters before referred to, I also have the honour of forwarding, for the information of the President and Council of the Royal Society, a copy of the lease, which, it will be seen, is held from Trinity College, Dublin, for the residue of a term of 99 years, of which about 25 years have expired. The obligations under the lease are not in any way onerous or likely to give trouble in the future.

Should the President and Council of the Royal Society assent to this proposal, as it is hoped they may do, there would seem to be no necessity for entering into any formal agreement between the Society and the Meteorological Council, which is in fact a Committee of the Royal Society, recognised by the Treasury for the discharge of certain duties.

* Not printed here.

The contemplated arrangement would constitute the Royal Society the absolute owners of the lease, on the understanding, first, that all pecuniary liabilities would be discharged by the Meteorological Council from the funds at its disposal; second, that in the event of circumstances arising of whatever nature, to lead the Royal Society to desire to sell the lease or otherwise dispose of it, they should have full power to do so at their discretion; and third, that in the event of the lease being sold, the net proceeds should be held at the disposal of the Treasury as required by their letter.

At the same time, I am to add that should the President and Council of the Royal Society be of opinion that any special precautions are required to protect their interests, the Meteorological Council will endeavour to meet their wishes so far as is practicable.

I am, &c.

(Signed) ROBERT H. SCOTT,
Secretary.

To the Secretary
of the Royal Society.

Royal Society, Burlington House,
January 17, 1891.

SIR,

YOUR letter dated January 12, 1891, has been laid before the President and Council of the Royal Society, and I am directed to reply as follows:—

The President and Council are willing to become the purchasers of the lease of the house at Valencia in Ireland, on the conditions named in your letter, viz.:

1. That the Meteorological Council should pay the sum demanded for the lease, viz., 1,400*l.* (fourteen hundred pounds), and all the costs of the purchase, and defray all other pecuniary liabilities connected with it, such as ground rent, rent and taxes, costs and repairs, including those rendered necessary by fire, storm, or tempest, insurance, &c., as stated in the lease.

2. That the Royal Society should have the power to sell the lease or otherwise dispose of it should such a course seem to them at any time desirable.

The President and Council on their part undertake, in the event of the lease being sold, to place the net results of such sale at the disposal of my Lords of the Treasury, as required by their letter of January 9, 1891.

I am, &c.

(Signed) M. FOSTER,
Secretary, Royal Society.

R. H. Scott, Esq.,
Secretary, Meteorological Council.

APPENDIX II.

Regulations for the Engagement and Examination of Boy Clerks at the Meteorological Office.

1. The salaries of boy clerks will begin at from 12*s.* 6*d.* to 15*s.* 6*d.* per week, according to the age of the lads, and will rise annually by 1*s.* 6*d.* per week up to a maximum of 20*s.* per week.

2. Candidates must not be less than 15 and not more than 17 years of age on the first day of the examination referred to in the next paragraph.

3. No boy shall be eligible to serve as a boy clerk in the Meteorological Office who has not passed an examination recognised by the Council as equivalent to that of the Civil Service Commission in the following subjects, viz.:—

Handwriting,
Orthography, and
Arithmetic, including vulgar and decimal fractions.

4. Boy clerks will not be retained as such after completing their 20th year, but will be eligible, subject to Rule 5, for appointment to the regular staff, when suitable vacancies occur, after two years (or if admitted after 17 years of age, one year) of good service, to the satisfaction of the Secretary.

They will also be considered eligible, subject to Rule 5, to fill suitable vacancies occurring within two years of their leaving the Office, provided they have served in it not less than two years.

5. No boy shall be eligible for appointment to the regular staff unless he has passed two of the examinations in the advanced stage of the Science and Art Department in the following subjects:—

a. Subject 5. Mathematics (II. Stage),
b. „ 6. Theoretical Mechanics,
c. „ 8. Sound, Light, and Heat,
d. „ 9. Magnetism and Electricity,
e. „ 10. Inorganic Chemistry,
f. „ 23. Physiography,

or the same subjects at any other examination recognised by the Council as equivalent.

6. It is to be clearly understood that boy clerks are liable to be discharged at the discretion of the Council on receiving one week's notice.

APPENDIX III.

List of Captains and Officers who have sent in Logs classed as "Excellent" during the year ending March 31, 1891. The figures opposite to each show the total number of such Logs which they have returned to the Office during the period that they have been observing.

Name of Captain or Officer.	Number of "Excellent" Logs.	Ship.
Andersen, O. E. - -	3	S.S. "Longhirst."
Angus, T. S. - - -	3	S.S. "Canton."
Atkinson, S. P. H. - -	4	"Hollinwood."
Balfour, Lieut. and Comr. A. F., R.N.	24	H.M.S. "Stork."
Baxter, A. S. - - -	5	"City of York."
Belding, R. - - -	3	"Atlantic."
Blackburne, Mr. H. S. - -	9	S.S. "Rohilla."
Bolton, S. H. - - -	11	S.S. "Baidar."
Bright, H. - - -	4	"Beltana."
Buchan, J. - - -	21	"Elise."
Buckler, J. H. - - -	1	S.S. "Essequibo."
Cameron, J. G., R.N.R. -	6	S.S. "Germanic."
Campbell, J. - - -	8	"Glengarry."
Campbell, R. - - -	5	S.S. "Elton."
Clapp, Comr. E. S., R.N. -	12	L.H. Tender "Richmond."
Clarke, Comr. A. C., R.N. -	3	H.M.S. "Espiègle."
Couper, W. - - -	3	"Clackmannanshire."
Crighton, A. T. - -	6	SS. "Circe" and S.S. "Amarynthia."
Cromarty, D. S. - -	4	"Cassandra."
Crowley, C. - - -	5	"Alexander Lawrence."
Crutchley, W. C., R.N.R. -	22	S.S. "Kaikoura."
Dart, L. C. - - -	11	"Semantha."
Dawson, Comr. L. S., R.N. -	10	H.M.S. "Rambler."
Day, Lieut. E. A., R.N. -	2	H.M.S. "Dart."
De Horne, M. - - -	2	S.S. "Rohilla."
Docherty, H. - - -	3	"Baron Colonsay."
Dunbar, J. I. - - -	20	S.S. "Arracan."
Elliott, W., R.N.R. - -	1	S.S. "Clan Murray."
England, T. - - -	10	"Jane."
Exham, T. K., F.R.A.S. -	9	S.S. "Esk" and S.S. "Tamar."
Field, Comr. A. M., R.N. -	5	H.M.S. "Egeria."
Frederick, Lieut. and Comr. G. C., R.N.	10	H.M.S. "Dart."
Garnsworthy, T. - -	2	S.S. "Ardancorrach."
George of Wales, H.R.H. Prince, Lieut. and Comr., K.G.	1	H.M.S. "Thrush."
Gilpin-Browne, Lieut. F. D., R.N.	1	H.M.S. "Egeria."
Gould, H. W. - - -	1	S.S. "Norse King."
Gray, J. - - -	14	S.S. "Hope."
Hepworth, C. M. W. - -	8	S.S. "Port Adelaide."
Home, Dr. W. E., R.N., B.Sc.	1	H.M.S. "Thrush."
Irving, P. J., R.N.R. - -	9	S.S. "Teutonic."

Name of Captain or Officer.	Number of "Excellent" Logs.	Ship.
Janes, G.	4	"Middlesex."
Jennings, R. C.	5	S.S. "Colina" and S.S. "Circe."
Kemp, A. H.	4	"Hudson."
Mesnard, T.	9	"Sierra Miranda."
Milne, W. F.	8	S.S. "Esquimaux" and S.S. "Polynia."
Milner, W. H.	10	S.S. "La Plata."
Mitchell, G.	3	S.S. "Trinacria."
Moignard, P.	5	"Fort James."
Molony, E. J.	9	"British Merchant."
Munn, L. A.	4	S.S. "Durban" and S.S. "Spartan."
Murdoch, P.	11	"Sierra Lucena."
Nicholson, J. I.	1	"Majestic."
North, W. G.	15	S.S. "Plato."
Oldham, Comr. C. F., R.N.	11	H.M.S. "Egeria."
Parry, M., F.R.Met.Soc.	16	S.S. "Prydain."
Parson, G. F.	10	"Earnock."
Peebles, R.	14	"Bracadale."
Pope, J.	4	S.S. "Dee."
Powles, F. W.	8	S.S. "Essequibo."
Price, J. H.	5	"Viola."
Pritchard, Lieut. C. E., R.N.	4	H.M.S. "Espiègle."
Quaile, D. W. A.	4	"Craigerne."
Randall, W.	12	"Laomene."
Ritchie, A.	3	"Four Winds."
Rosseter, W. L.	12	"Columba" and "Brenda."
Sargent, A. H.	5	"Pleione."
Scott, G.	5	"Holyrood."
Scott, W.	21	"Winifred."
Simpson, A.	13	S.S. "Australasian."
Simpson, A.	20	S.S. "Traveller."
Somerville, Lieut. Boyle T., R.N.	2	H.M.S. "Dart."
Speck, F.	2	S.S. "Rohilla."
Squares, Mr. W. G.	1	S.S. "Minia."
Streater, R.	1	"Lutterworth."
Thompson, Lieut. H., R.N.	4	H.M.S. "Rambler."
Tizard, Staff-Capt. T. H., R.N.	11	H.M.S. "Triton."
Travers, H. D.	9	S.S. "Tartar."
Trenaman, R. W.	2	S.S. "Pascal."
Trevor-Roper, Dr. G. D., R.N.	2	H.M.S. "Stork."
Trott, S., F.R.Met.Soc.	18	S.S. "Minia."
Wait, A. M.	5	S.S. "Spartan."
Walker, H., R.N.R.	13	S.S. "Servia."
Wheaton, N. J.	12	"Eliza."
Wilson, J., R.N.R.	6	S.S. "Ethiopia."
Woolward, R.	7	S.S "Nile" and S.S. "Don."
Young, Mr. W. H.	1	S.S. "Clan Murray."

Names of deceased observers printed in italics.

APPENDIX IV.—Ships supplied and Documents returned during the year ending 31st March 1891.

The number of merchant ships supplied with standard instruments and meteorological logs during the above period was 86.

The number of meteorological logs, and documents from Foreign Stations, received during the same period, and registered in the Office, amounted altogether to 321, of which 184 were returned from ships, and the remainder from land stations, outside the British Isles.

List of Documents received from Foreign Land Stations.

Place.	Observer.	No. of Documents.	Nature of Observations.
Abaco (Bahamas) - -	T. R. Thompson, sen., and C. A. Strachan, Lightkeepers.	3	"Lighthouse" Register, 1889, July to December; 1890, January to December.
Akassa, Nun River, Niger Delta -	Frank Russell, F.R.G.S. -	2	Two observations daily, 1889, December; 1890 January to March.
Beyrout (Lee Observatory) -	R. H. West, M.A. - -	11	" " " 1890, March to December; 1891, January.
Brumana (Mt. Lebanon) -	Thomas Little - -	1	" " " 1891, February.
Cape Juby (N.W. Africa) -	Hubert Bray, M.R.C.S., L.R.C.P.	9	" " " 1890, February to November.
Cape Pembroke (Falkland Islands)	G. K. Broom, Lightkeeper -	2	"Lighthouse" Register 1890, January to December.
Cay Lobos (Bahamas) - -	Lightkeepers - -	2	" " 1890, January to December.
Cay Sal (Bahamas) - -	T. R. Thompson, Sen., Lightkeeper.	2	" " 1890, January to December.
Famagusta (Cyprus) - -	G. Eliades - - -	3	Two observations daily, 1889, January to December.
George Town (British Guiana) -	Robert Ward - -	9	" " " 1890, February to December; 1891, January.
Gibraltar - - - -	Staff-Sergeant H. Spackman, and Sergeant R. Scott, Med. Staff Corps.	12	" " " 1890, February to December; 1891, January.

List of Documents—*continued.*

Place.	Observer.	No. of Documents.	Nature of Observations.
Grand Bassam - - -	G. Baillan, West African Tel. Co.	2	Two observations daily, 1890, March, April.
Heligoland - - -	J. J. Friederichs, Lightkeeper	10	„ „ „ 1890, March to December.
Inagua (Bahamas) - -	Lightkeepers - -	1	"Lighthouse" Register, 1890, February to August.
Kyrenia (Cyprus) - -	M. Fuleiham and C. Natais -	3	Two observations daily, 1889, January to December.
Larnaca (Cyprus) - -	G. P. Voudiziano - -	3	„ „ „ „ „
Limassol (Cyprus) - -	Luigi Béraud - -	3	„ „ „ „ „
Nicosia (Cyprus) - -	G. Stephen - - -	3	„ „ „ „ „
Papho (Cyprus) - - -	E. A. Malliotis - -	3	„ „ „ „ „
Principe Island (West Africa) -	G. R. Scovell - -	9	„ „ „ 1890, February to October; 1891, January.
Suva (Fiji) - - -	J. D. W. Vaughan, F.R.Met. Soc.	7	One observation daily. 1890, January to April, July to November.
Teneriffe (San Antonio) - -	Mrs. W. L. Boreham	4	Two observations daily, 1890, February, November, December; 1891, January.
Teneriffe (Sitio de Cullen) -	A. F. Perry - -	7	„ „ „ 1890, March to December; 1891, January.
Tobago - - - -	J. P. Tulloch, M.A., M.D. -	12	„ „ „ 1890, January to December; 1891, January, February.
Trinidad - - - -	J. H. Hart, Supt. Botanic Gardens.	11	„ „ „ 1890, February to December; 1891, January.
Valua Island (Banks Archipelago)	W. Ford - - -	1	One observation daily, January 1887 to September 1890.
Watling Island (Bahamas) -	T. R. Thompson, jun., Lightkeeper.	1	"Lighthouse" Register, 1890, January to December.

List of Documents received from Ships.

Captain's Name.	Ship.	Voyage.	Year.
Andersen, O. E.	S.S. Longhirst	Algoa Bay, Akyab	1889–90
" "	"	Genoa, Philadelphia, Bremerhaven	1890
" "	"	Genoa, Philadelphia	1890
Anderson, Charles	S.S. Achilles	China, viâ Suez	1888–89
Angus, T. S.	S.S. Canton	" "	1890
[1] " "	"	" "	1890
Armstrong, B. G.	R.M.S. Elbe	Brazil	1889–90
[2] " "	"	East coast of South America, Barbadoes	1890–91
Asquith, W.	S.S. Deucalion	China, viâ Suez	1888
Atkinson, S. P. H.	Hollinwood	Melbourne, San Francisco	1889–90
[3] Balfour, Lieut. and Comr. A. F., R.N.	H.M.S. Stork	Simon's Bay, East coast of Africa	1889–90
Barker, R. J. M.	Barque Earl of Aberdeen	Calcutta	1889–90
Bartlett, T.	S.S. Diomed	China, viâ Suez	1889
Baxter, A. S.	City of York	Rio Janeiro, Rangoon	1889–90
Behenna, Richard	Loch Katrine	Melbourne	1890
Belding, Rawstin	Barque Atlantic	River Plate	1890
Bennett, J. T.	Alcester	Batavia	1889–90
[4] Berwick, G. R.	S.S. Strathleven	Chinese Ports, New York, viâ Suez	1890
Bigley, W. B.	S.S. Diomed	China, viâ Suez	1888
Bolton, S. H.	S.S. Baidar	Continental Ports	1890
" "	"	" "	1890
Bright, Henry	Barque Beltana	Adelaide	1889–90
Brown, R. J.	S.S. Titan	China, viâ Suez	1888
Buchan, James	Barquentine Elise	Demerara, Philadelphia	1890
[5] Buckler, J. H.	S.S. Essequibo	West Indies	1890
Bulkeley, T. D.	S.S. Derwent	" "	1889–90
[6] Cameron, J. G., R.N.R.	S.S. Germanic	New York	1890
Campbell, James	Glengarry	Rangoon	1890–91
[7] Campbell, Robert	S.S. Elton	Bombay, viâ Suez, Alexandria, Sulina	1890
[7] " "	"	Ports in the Black Sea and Mediterranean	1890
[8] Clapp, E. S., R.N.	Schooner Richmond	Bahamas	1890
[8] " "	"	"	1890
[9] Clarke, Comr. A. C., R.N.	H.M.S. Espiègle	Esquimalt, Honolulu, Malden Island, Acapulco	1889–90
Cook, T. H.	S.S. Gulf of St. Vincent	Valparaiso	1890
Couper, William	Clackmannanshire	Sydney	1889–90
Crighton, A. T.	S.S. Amarynthia	Montreal	1890
" "	S.S. Circe	Baltimore	1890
Cromarty, D. S.	Barque Cassandra	New York, Adelaide	1889–90
Crowley, C.	Barque Alexander Lawrence.	New York, Madras, Mauritius	1889–90
Crozier, F. R. M.	H.M.S. Terror		1839–42
" "	"		1839–42
[10] Crutchley, W. C., R.N.R.	R.M.S. Kaikoura	Cape Town, Hobart, Rio Janeiro	1890
[10] " " "	"	" " " "	1890
[11] " " "	"	Cape Town, Wellington, Rio Janeiro	1890–91
Dart, L. C.	Semantha	Calcutta	1889–90
[12] Davies, David	Andora	San Francisco, Sydney	1889–90
[13] Dawson, Comr. L. S., R.N.	H.M.S. Rambler	Sydney, Hong-Kong	1890
[13] " " "	"	China Sea	1890
[14] De Horne, M.	S.S. Rohilla	China, viâ Suez	1890
Dickinson, L. R.	S.S. Atrato	Brazil	1890
Docherty, Hugh	Baron Colonsay	Singapore	1889–90

Captain's Name.	Ship.	Voyage.	Year.
Docherty, Hugh	Baron Colonsay	Port Pirie	1890–91
Dunbar, J. I.	S.S. Arracan	Rangoon, viâ Suez	1890
„ „	„	„ „	1890
„ „	„	„ „	1890–91
Elliott, Wm., R.N.R.	S.S. Clan Alpine	Cape Town, Colombo	1890
[5] „ „	S.S. Clan Murray	Cape Town, Ceylon, home viâ Suez	1890
„ „	„ „	Ceylon, viâ Cape Town, home viâ Suez	1890
England, Thomas	Barque Jane	Demerara	1889–90
„ „	„	Quebec	1890
[5] Exham, T. K.	R.M.S. Esk	West Indies	1889–90
[5] „ „	„	„	1890
„ „	S.S. Tamar	Brazil	1890
[16] Field, Comr. A. M., R.N.	H.M.S. Egeria	Thursday Island, Singapore, Hong-Kong	1890
Fordyce, William	County of Edinburgh	Calcutta	1888–89
Foster, Henry	H.M.S. Chanticleer	Madeira, Fernando de Noronha, Cape of Good Hope, Staten Island, Deception Island	1828–29
„ „	„	Staten Island, Deception Island, St. Martin's Cove	1828–29
[17] Frederick, Lieut. and Comr. G. C., R.N.	H.M.S. Dart	Surveying off Queensland	1889
[17] „ „	„	At Australian station	1889–90
[18] „ „	„	„ „	1890
[18] „ „	„	Australian station, Sandwich Island, New Hebrides	1890
Garnsworthy, Thomas	S.S. Ardancorrack	Havanna, New York, Norfolk (Va.)	1890
[19] George of Wales, Lieut. and Comr. H.R.H. Prince, K.G.	H.M.S. Thrush	Gibraltar, Las Palmas, Bermuda, Halifax	1890
[19] „ „	„	Halifax, Bermuda, Jamaica	1890–91
[20] Gillies, W.	S.S. Medway	West Indies	1889–90
„	„	Jamaica, Barbadoes	1890
Gordon, G. G.	Falkland Hill	Cape Town, Lyttleton	1889–90
[21] Gould, H. W.	S.S. Norse King	Montreal	1890
[22] Gray, John	S.S. Hope	Greenland	1890
[23] Griffin, E. J., R.N.R.	R.M.S. Moor	Cape Town	1889–90
[24] „ „	„	„	1890
[24] „ „	„	„	1890–91
Guthrie, W. E.	S.S. Bellerophon	China, viâ Suez	1888
Hannah, W. T.	S.S. Glaucus	„	1888–89
[5] Hepworth, C. M. W.	S.S. Port Adelaide	Adelaide, viâ Cape of Good Hope, home viâ Suez	1890
[25] Hicks, G. M.	S.S. Thames	Lisbon, Brazil	1890
Hutchinson, I.	S.S. Orestes	China, viâ Suez	1888–89
[26] Huxtable, R. G.	Barque Lanarkshire	Brisbane, New Caledonia	1890
[27] Irving, P. J.	S.S. Teutonic	New York	1890
Jackson, Charles	S.S. Palamed	China, viâ Suez	1888–89
„ M. H. F.	S.S. Telamon	„	1889
„ T. S.	S.S. Palinurus	„	1888
JAnes, George	Middlesex	Singapore	1889–90
Jennings, R. C.	S.S. Colina	Halifax	1889–90
[28] „ „	S.S. Circe	Montreal	1890
„ „	„	„	1890
Jones, Henry	S.S. Telemachus	China, viâ Suez	1888–89
Kemp, A. H.	Barque Hudson	New Zealand	1890
[5] King, James	City of Hankow	Monte Video, Philadelphia, Hiogo, San Francisco	1889–91
Lapage, W. P.	S.S. Anchises	China, viâ Suez	1888–89
Martin, T. C.	Loch Tay	Melbourne	1890–91

	Captain's Name.	Ship.	Voyage.	Y
29	Martin, W.	S.S. German	Cape Town	18
30	"	"	"	189
	Mesnard, Thomas	Sierra Miranda	" Chittagong	188
31	Miller, A. T., R.N.	H.M.S. Conway	Off Birkenhead	18
	Milligan, John	S.S. Jason	China, viâ Suez	188
	" S.	S.S. Stentor	" "	188
	Milne, W. F.	S.S. Esquimaux	St. John's, Newfoundland	18
	" "	S.S. Polynia	Baffin's Bay	18
32	Milner, W. H.	R.M.S. La Plata	Brazil	18
	" "	" "	W. coast of South America	18
	Mitchell, George	S.S. Trinacria	Genoa, Philadelphia	188
	" "	"	Gibraltar, New York, Mediterranean Ports	189
	Moignard, Philip	Fort James	San Francisco	189
	Molony, E. J.	British Merchant	Melbourne, San Francisco	189
33	Munn, L. A.	S.S. Durban	Cape Town	188
33	" "	"	"	18
34	" "	S.S. Spartan	"	18
	Murdoch, Peter	Sierra Lucena	Melbourne, Rangoon	188
	Murray, Alexander	S.S. Perseverance	Cumberland Straits	18
	Nicholson, J. I.	Majestic	Calcutta	189
	Nish, H.	S.S. Cyclops	China, viâ Suez	188
	North, W. G.	S.S. Plato	Hamburg	188
	" "	"	"	18
	" "	"	"	18
	Oldham, Comr. C. F., R.N.	H.M.S. Egeria	Sydney, Tongatabu	18
16	" "	"	Thursday Island, Singapore, Hong-Kong	18
	Parry, Moses	S.S. Prydain	New Orleans, Norfolk (Va.)	18
	Parson, G. F.	Earnock	Port Pirie	188
	Pattman, R.	Barque Loch Torridon	Calcutta	188
	Pearson, C. W.	S.S. Strathleven	Japan, viâ Suez	188
	Peebles, R.	Bracadale	New York, Calcutta	188
	Pike, Thomas	Ben Voirlich	Guayaquil	188
35	Pope, James	R.M.S. Dee	West Indies	188
35	" "	"	"	18
5	Powles, F. W.	R.M.S. Essequibo	"	18
5	" "	"	"	18
	Price, J. H.	Barque Viola	Buenos Ayres, Calcutta, Pisagua	188
	Pulford, J.	S.S. Patroclus	China, viâ Suez	18
	Purdy, Thomas	S.S. Dardanus	"	188
36	Puttkamer, A. von	Barque Elvira	Paysandu, Calcutta, Buenos Ayres	188
	Quaile, D. W. A.	Barque Craigerne	Sydney, San Francisco	188
	Randall, W.	Laomene	Melbourne, Pisagua	188
29	Reynolds, —	S.S. German	Cape Town	188
37	Rigaud, H. C.	R.M.S. Tamar	River Plate	188
	" "	"	" "	18
	Riley, James	S.S. Ajax	China, viâ Suez	188
	Ritchie, Alexander	Four Winds	Calcutta	188
	Ross, J. C.	H.M.S. Erebus		183
	" "	"		183
	" "	"		18
38	Rosseter, W. L.	Brenda	Calcutta, Demerara, New York	189
	" "	Columba	Calcutta, Mauritius, New York	188
6	Sargent, A. H.	Pleione	Wellington	189
	Scale, R. F.	S.S. Laertes	China, viâ Suez	188
	Scott, George	Holyrood	New York, Calcutta	188
	" William	Barquentine Winifred	Rio Grand de Sul	188
	Simpson, Alexander (No. 90,667).	S.S. Australasian	Melbourne, viâ Cape Town	188
	" "	"	Australia, viâ Cape of Good Hope, Batavia, and home viâ Suez	189

	Captain's Name.	Ship.	Voyage.	Year.
	Simpson, Alexander (No. 19,865).	Barquentine Traveller	Greenland - - - -	1889–90
	Smith, E. J. -	S.S. Adriatic - -	New York - - - -	1890
31	Smith, J. H., R N.R.	H.M.S. Worcester -	Off Greenhithe - - -	1890
39	Speck, F. - -	S.S. Rohilla - -	Bombay, Shanghai - -	1890
40	" " -	" - -	Calcutta, viâ Suez - -	1890–91
	Stewart, Alexander -	County of Selkirk -	Calcutta - - - -	1890–91
	Streater, R. - -	Barque Lutterworth -	Wellington - - -	1889–90
	Stroak, J. D. -	County of Roxburgh -	Calcutta - - - -	1890–91
	Swynnerton, Godfrey	S.S. Lennox - -	China, viâ Suez - - -	1889–90
	" "	" - -	Hong-Kong, Yokohama, Singapore to New York, viâ Suez -	1890
41	Symmers, John -	Barque Inverurie -	Rangoon, Rio Janeiro - -	1889–90
42	Symons, F. J., R.N.R.	S.S. Dane - -	Cape Town - - -	1889–90
	Thompson, J. S. -	S.S. Nestor - -	China, viâ Suez - - -	1888
	Tizard, Staff Capt. T. H., R.N.	H.M.S. Triton - -	Off British Isles - - -	1884–5
	" "	" - -	" - - -	1890
43	Travers, H. D. -	R.M.S. Tartar - -	Cape Town - - -	1889–90
44	" " -	" - -	" - - -	1890
45	Treneman, R.W. -	S.S. Pascal - -	River Plate - - -	1889–90
45	" " -	" - -	Lisbon, Rio Janeiro, New Orleans	1890
	Trott, Samuel -	S.S. Minia - -	Halifax - - - -	1890
46	" " -	" - -	Nova Scotia - - -	1890–91
47	Wait, A. McLean -	R.M.S. Spartan -	Cape Town - - -	1889–90
	" " -	" - -	" - - -	1890
48	" " -	S.S. Tartar - -	" - - -	1890
	Walker, Henry, R.N.R.	S.S. Servia - -	New York - - - -	1889–90
	" "	" - -	" - - -	1890–91
	Wheaton, N. J. -	Barque Eliza - -	Rio Janeiro, Barbadoes - -	1890
	" " -	" - -	Ceara (Brazil) - - -	1890–91
	Wilding, J. -	S.S. Agamemnon -	China, viâ Suez - - -	1888
49	Williams, John -	Barque Elissa - -	Monte Video, Barbadoes, Georgia	1889–90
	Wilson, John, R.N.R.	S.S. Ethiopia - -	New York - - -	1889–90
	" " "	" - -	" - - -	1890
50	Woolward, R. -	R.M.S. Don - -	West Indies - - -	1890
50	" " -	" - -	" -	1890
50	" "	R.M.S. Nile - -	" - - -	1890

In cases distinguished by marginal numbers the Meteorological Registers were kept chiefly by Officers, as follows:—

1 Assisted by W. B. Palmer, 2nd Officer, C. A. Williams, 3rd Officer, and H. W. Potter, 4th Officer.
2 Kept by C. Cottman.
3 Kept by G. D. Trevor-Roper, Surgeon R.N.
4 Kept by John Kynoch, 2nd Mate.
5 Assisted by Officers.
6 Kept by J. T. Shenton.
7 Assisted by C. Matthews and R. Knill.
8 Kept by Fred. W. Holden.
9 Kept by Lieut. C. E. Pritchard, R.N.
10 Kept by H. C. Kiddle.
11 Kept by W. L. Paske, 4th Officer.
12 Assisted by 1st Officer.
13 Kept by Lieut. Henry Thompson, R.N.
14 Kept by E. C. Carter, 4th Officer, D. Asbury, 5th Officer, and N. K. Cornish, 4th Officer.
15 Kept by W. H. Young, 2nd Officer.
16 Kept by F. D. Gilpin-Brown, R.N.
17 Kept by Lieut. Boyle T. Somerville, R.N.
18 Kept by Lieut. E. A. Day, R.N.
19 Kept by William E. Home, B.Sc., M.B., Surgeon, R.N.
20 Kept by William Anderson, 2nd Officer.
21 Assisted by John Beavan and E. C. Crosby, 1st and 2nd Mates.
22 Kept by Oscar Lundus, Mate.
23 Kept by J. V. Williams, 4th Officer.
24 Kept by H. E. Butler, 4th Officer.
25 Kept by W. H. Fooks.
26 Kept by Lockhart W. McLaren.
27 Kept by Walter L. D. Chapman, 2nd Officer.
28 Kept by John Dickie, 2nd Officer.
29 Kept by A. H. Rhodes, 3rd Officer.
30 Kept by J. George, 3rd Officer.
31 Kept by the Cadets.
32 Kept by Mr. Moses, 3rd Officer.
33 Kept by R. H. Sach, 3rd Officer.
34 Kept by J. J. Brickhill, F.R.G.S.
35 Kept by A. Jolliffe, 2nd Officer.
36 Kept by Cecil R. A. Newby and Charles M. Redhead, R.N.R.
37 Kept by A. Hackland, 2nd Officer, C. Langmaid, 3rd Officer, and J. Mien, 4th Officer.
38 Assisted by Mr. Rosewarne, 1st Officer.
39 Kept by H. S. Blackburn, Chief Officer, F. Hayes, 4th Officer, and D. Asbury, 5th Officer.
40 Kept by the Officers.
41 Kept by George Dawson, Chief Officer.
42 Kept by G. H. Watkins, 2nd Officer.
43 Kept by James Bowyer, 2nd Officer.
44 Kept by C. R. Taylor, 3rd Officer.
45 Assisted by 2nd Officer
46 Kept by W. G. Squares, Chief Officer.
47 Kept by H. P. Adams, 4th Officer.
48 Kept by John Bernard, 4th Officer
49 Kept by William Tait and H. Woodcock.
50 Kept by P. S. Newton, 2nd Officer.

APPENDIX V.

INSTRUMENTS supplied, &c. to the Royal Navy.

Per Account.	Barometers.	Aneroids.	Thermometers.				Hydrometers.
			Ordinary.	Max.	Min.	Screens.	
April 1st, 1890, afloat	211	480	1,328	289	258	167	53
Issued since	75	126	365	66	60	30	53
	286	606	1,693	355	318	197	106
Returned since	77	108	325	51	41	29	24
April 1st, 1891, afloat	209	498	1,368	304	277	168	82

INSTRUMENTS supplied, &c. for use at Naval Stations.

April 1st, 1890, in use	61	63	208	21	21	3	11
Issued since	11	4	98	9	8	2	1
	72	67	306	30	29	5	12
Returned since	4	2	28	2	2	—	—
April 1st, 1891, in use	68	65	278	28	27	5	12

DISPOSITION of ADMIRALTY INSTRUMENTS on April 1st, 1891.

Afloat in Royal Navy	209	498	1,368	304	277	168	82
In use at stations	68	65	278	28	27	5	12
In store at M.O.	46	49	224	92	110	24	38
„ Chatham	7	10	6	6	7	—	13
„ Sheerness	5	3	32	8	8	5	9
„ Portsmouth	19	50	28	7	11	5	5
„ Devonport	16	34	46	12	13	5	16
„ Queenstown	2	4	21	1	1	—	4
„ Gibraltar	1	1	8	—	—	—	4
„ Malta	11	16	56	8	12	2	17
„ Bombay	4	3	12	4	4	1	4
„ Halifax	4	10	24	3	5	—	14
„ Bermuda	4	12	25	3	5	2	15
„ Jamaica	4	3	31	2	2	—	—
„ Cape of Good Hope	4	7	30	5	6	3	4
„ Trincomalee	4	3	21	4	4	—	—
„ Hong Kong	6	20	12	7	5	—	17
„ Coquimbo	5	4	20	1	1	—	19
„ Sydney	3	5	23	5	3	—	8
„ Esquimalt	9	8	24	3	3	—	—
Total, April 1st, 1891	431	805	2,289	503	504	220	281
Lost, &c. since April 1st, 1890	2	11	294	30	10	15	18
Under repair	8	12	—	—	—	—	—

APPENDIX VI.

INSTRUMENTS supplied, &c. to Mercantile Marine.

Per Account.	Barometers.	Compasses.	Thermometers.				Hydrometers.
			Ordinary.	Max.	Min.	Screens.	
April 1st, 1890, afloat - -	107	—	636	—	—	106	342
Issued since - - -	41	—	284	—	—	40	131
	148	—	920	—	—	146	473
Returned since - -	53	—	365	—	—	58	192
April 1st, 1891, afloat - -	95	—	555	—	—	88	281

INSTRUMENTS at Stations, viz., Telegraph Offices, Observatories, Fishing Villages, &c.

April 1st, 1890, in use - -	256	4	247	55	57	54	11
Issued since - - -	13	—	12	6	7	3	2
	269	4	259	61	64	57	13
Returned since - -	13	1	17	8	6	4	2
April 1st, 1891, in use - -	256	3	242	53	58	53	11

DISPOSITION of Board of Trade Instruments on April 1st, 1891.

In merchant ships - -	95	—	555	—	—	88	281
In use at stations - -	256	3	242	53	58	53	11
In store at M.O. - -	64	3	299	21	33	60	137
At Liverpool Agency -	7	7	33	—	—	4	34
„ Aberdeen „ -	3	—	22	—	3	4	12
„ Glasgow „ -	8	—	53	—	—	8	32
„ Dundee „ -	17	—	37	—	—	13	38
„ Hull „ -	8	—	30	—	—	6	26
„ Southampton „ -	7	—	24	—	—	11	34
Total, April 1st, 1891 -	465	13	1,295	74	94	247	605
Lost, &c. since April 1st, 1890	1	—	84	2	1	14	18
Under repair - -	1	—	—	—	—	—	—

APPENDIX VII.

List of Stations reporting Meteorological Observations to the Office by Telegraph on 31st March 1891, with the Names of Observers.

*†Sumburgh Head	Rev. W. Brand	Minister of Dunrossness.
*†Stornoway	J. Forbes	Nicolson Institution.
Wick	J. Sinclair	Watchmaker.
Nairn	Miss Penny	Schoolmistress.
*†Aberdeen	W. Boswell	Assistant at the Observatory.
Leith	W. Hay	Telegraph Clerk.
*†Shields	J. W. Irvine	Do.
Spurn Head	J. H. Watson	Lightkeeper.
†York	H. M. Platnauer, F.G.S.	Curator of Museum.
Loughboro'	W. Berridge	—
†Ardrossan	J. W. Mayes	Telegraph Clerk.
Malin Head	O. O'Doherty	Signalman, Lloyd's.
*†Mullaghmore	K. Kerr	Retired Coastguard Officer.
*†Belmullet	Miss M. J. Tolan	Telegraphist.
†Donaghadee	T. MacGowan	Postmaster.
Parsonstown	E. Haines	Assistant Observer at Lord Rosse's Observatory.
*†Holyhead	Capt. Richards	Keeper of Sailors' Home.
Liverpool	J. Hartnup, F.R.Met.Soc.	Bidston Observatory.
*†Valencia	J. E. Cullum, F.R.Met.Soc.	Superintendent of the Observatory.
†Roche's Point	W. Kennedy	Telegraph Clerk.
Pembroke	S. Blake	Lightkeeper.
*†Scilly	A. Hicks	Signalman.
Prawle Point	W. Hewitt	Coastguard Officer.
†Hurst Castle	G. G. Appleton	Lightkeeper.
†Jersey	J. Fisher	Station Master.
*†Dungeness	W. Batton	Assistant Lightkeeper.
*†London	F. Gaster, F.R.Met.Soc.	Clerk, Meteorological Office.
Oxford	W. Wickham	Radcliffe Observatory.
Cambridge	H. Todd	Observatory.
*†Yarmouth	G. T. Watson	Secretary, Sailors' Home.
‡Hawes Junction	W. H. Bunce	Station Master.

In addition to the above, reports are received daily from the following Continental Stations.

Station.	Authority.	Station.	Authority.
Haparanda	Meteorological Office, Sweden.	†The Helder	Bureau Central Météorologique, Paris.
Hernösand		Cape Gris Nez	
†Stockholm		†Brest (St. Mathieu)	
Wisby		Lorient (Île de Groix)	
Bodö	Meteorological Institute, Norway.	*†Rochefort (Ile d'Aix)	
†Christiansund		†Biarritz	
*†Skudesnaes		†Paris	
Færder		Belfort	
		Lyons	
		Nice	
†The Scaw	Meteorological Institute, Denmark.	Perpignan	
Fanö		Berlin	Cent. Met. Inst. of Germany.
Cuxhaven	Deutsche Seewarte, Hamburg.	Wiesbaden	
		Munich	
		Corunna	Observatory, Lisbon.
		†Lisbon	

Note.—The stations marked with an asterisk (*) report also at 2h. p.m.; and those with a dagger (†) at 6h. p.m.; Lisbon reports at 8h. a.m. and 4h. p.m.

‡ This station now reports by post only.

Paris has ceased reporting at 6 p.m. on Sundays.

APPENDIX VIII.

Report of Inspections, Ireland and Wales.

Gentlemen,

I have to report that I have completed my usual inspections. The only stations unvisited on this occasion have been Malin Head (telegraphic), Londonderry (Second Order), and two Weekly Weather Report stations, Llandovery and Kilkenny.

Telegraphic Stations.

St. Ann's Head, visited September 25.—This station calls for no remark.

Roche's Point, visited September 27.—I found that a new rain-gauge was required, and it has been supplied.

Valencia, visited October 1.—The only matter calling for notice is that there are frequent complaints of delay in the telegrams, owing to lateness of attendance at the local post office. I have further remarks on this station, which will be found in the next section of the Report.

Donaghadee, visited October 6.—This station is good, but the observer's health is not satisfactory, and in damp weather the observations are taken by substitutes, who are fairly competent.

Mullaghmore, visited October 9.—The station is in good order. An endeavour is being made to have the wire carried to the post office here. If this is done it would release the Office from its engagements as to the private wire.

Belmullet, visited October 11.—The station is in good order, but, as is usual at other stations, the space available for rain-gauge and thermometer screen is not adequate.

Parsonstown, visited October 16.—The station is in good order. The wind observations are not satisfactory, as the demesne is thickly wooded. The Council can gather the effect of this from a remark of Dr. Bœddicker's to me, to the effect that, he was often able to photograph with the 3-foot reflector when there was a breeze outside in the open country.

Holyhead, visited October 21.—This station is also in good order. I saw the bridled anemometer. The new arrangement of cups, as ordered by Sir G. Stokes, has been carried out. The instrument has occasionally been worked with quick motion, so as to expand the time scale.

On the whole, I can say that I found all the telegraphic reporters attentive and efficient, and the instruments clean and in reasonably good order.

Tory Island.—As regards the proposed change of the Lloyd's signal station from Malin Head to Tory Island, I learnt, when I was on the coast, on the authority of a lightkeeper now stationed at Tory, that Lloyd's have been unable to get the materials for the proposed signalman's residence landed before the winter, so that this station cannot be ready before Easter.

The regular communication with the island is by post boat (sailing), from Gort-a-hork coastguard station, near the Bloody Foreland, distant about 10 miles from the island. There is no sleeping accommodation near Gort-a-hork, and the post boat only sails once a week. I hear the

the hire of a special boat is 35*s.* at least. Passengers can reach Tory by the steamer from Sligo to Glasgow, landing in a boat. This route probably involves a stay of about four days on the island.

Second Order Stations and Observatories.

St. David's, visited September 24.—The station was, as usual, in excellent order.

Valencia Observatory, visited October 1.—I did not examine the S.R. apparatus, as Mr. Baker was expected in a week from my visit.

I found that the Post Office authorities had not yet removed the posts and wire from Kilbeg Hill. There is a certain quantity of apparatus, cells, &c. at the observatory, the property of the Council. I have instructed Mr. Cullum to prepare a list of this, and send it up for your instructions as to its disposal.

I visited Westwood House, 1 mile from Cahirciveen. This is now vacant. It is an ordinary dwelling-house standing in 20 acres of land, with frontage to road and sea, held under a direct lease from Trinity College, with 60 years to run.

Its situation is much more open than the present locality of the observatory, and the fact of its being within a mile of the town, without the intervention of a ferry, would render communication much easier and cheaper.

Dublin, Mountjoy Observatory, visited October 4.—The observer at this station has been changed, Sergeant Lipscombe having retired; Corporal Stone now takes the observations. He is careful and efficient.

Dublin, Glasnevin Gardens, visited October 4.—This station goes on satisfactorily. We have not had of late as much interference with the instruments by children visiting the gardens as in former years.

Dublin (*Fitzwilliam Square*), visited October 4.—The station calls for no remark; it is always in excellent order.

Lissan, visited October 7.—This is a new station, the records from which are supplied by the Scottish Meteorological Society. It is the property of Sir N. Staples, Bart., who, when at home, is the observer. His substitute, J. Donaldson, the gardener, is very efficient.

The instruments are not of the quality usual at Second Order Stations, as only one of the thermometers is graduated on the stem. The barometer is of the Kew pattern, by Adie of Edinburgh, but bears no distinguishing number that I could discover. The rain-gauge is worn out.

The observer, Donaldson, had received no printed instructions at any time.

The situation of this station is good; the country about is undulating, but less so than at Armagh.

Slieve Gallion, height 1,500 feet, is distant about 4 miles on the North and N.N.W.

Armagh, visited October 8.—The instruments are all in good order. At this station there is an old standard barometer by Newman, which seems to be a very good instrument. I propose that the Council should have this cleaned; and then their own standard, supplied in 1868, might be recalled, and be available for use elsewhere.

Colebrooke, Brookeborough, visited October 8.—This station calls for no special remark.

Markree, visited October 10.—This station is in very good order, Mr. Marth having trained his servant to take the readings accurately.

Currygrane, visited October 15.—This station is satisfactory, the new observer being now quite efficient.

Parsonstown, visited October 16.—At this station a new observer takes the 9 p.m. readings. His name is White, and he has had previous training, so that the work is well done.

I also visited a few fishery barometers and a sunshine record station.

Ballycastle, co. Antrim, visited October 18.—A barometer supplied to this station last summer was reported to be useless. I went down specially and found air in the tube, which I removed.

Carnarvon, visited October 22.—The barometer is suspended just inside the entrance door of the Custom House, and is probably attended to, the diagram being kept correctly. Mr. Holmes, the collector, is a very old correspondent of the Office.

Nevin or *Morfa Nevin*.—A barometer was supplied at Mr. Holmes's suggestion last spring. On inquiry, I found that it had been erected in a private house. I wrote (P.C. 1782) to the effect that it must be erected in some situation accessible to the public, and Mr. Holmes has promised to see that this is done, as the place is within his district. He had never been informed that the barometer had been received. He told me that the same thing had occurred at Carnarvon before his arrival, a barometer supplied for Abersoch, had been intercepted in transit at Carnarvon and suspended in a private house. This is the barometer above referred to as at the Custom House.

Llandudno, visited October 22.—I went to this station to see the sunshine recorder which had been transferred from the Great Orme's Head to the end of the pier by Mr. Whipple in the summer. I found it still somewhat out in level and in azimuth, but set it right. The man in charge of it, John Roberts, the piermaster, seems very intelligent and careful.

Weekly Weather Report Stations.

Waterford, visited September 26.—The observations are carefully taken.

Foynes, visited October 2.—This station is in good order, but the observations are only kept up when Lord Monteagle is at home.

Corrections to be applied to readings of—

Stations.	Dry Bulb.	Wet Bulb.	Max.	Min.	Spare Therm.	Remarks.
Stations of the Second Order.						
Armagh	−0·2	−0·3	−1·0	—	—	Grass min. +0·7. Kew standard −1·2.
Brookeborough	−0·5	−1·0	−0·1	+1·0	—	Observer reads high.
Dublin (City)	−0·3	−0·3	−0·8	0·0	—	
Dublin (Phœnix Park)	−0·4	−0·5	−0·2	0·0	−1·0	Grass min. −0·5.
Edgeworthstown	−0·6	−0·6	−0·6	+0·2	—	Do. +0·4.
Glasnevin	−0·2	−0·4	−1·0	+0·4	—	Do. −0·2.
Lissan	−0·8	−0·9	0·0	+0·5	—	
Markree Castle	−0·1	−0·2	0·0	+0·1	−0·2	Kew standard −0·1
Parsonstown	−0·5	0·0	−0·4	0·0	—	
St. David's	−0·2	−0·3	0·0	−0·1	—	Grass min. −0·2.

Stations.	Dry Bulb.	Wet Bulb.	Max.	Min.	Spare Therm.	Remarks.
Telegraphic Reporting Stations.						
Holyhead	−0·1	−0·2	−0·2	+0·4	−0·2	
Mullaghmore	−0·1	−0·1	+0·1	+0·5	−0·2	
Belmullet	−0·2	−0·1	−0·1	−0·2	—	No spare ther.
Donaghadee	−0·5	−0·6	−0·1	−0·3	−0·5	
Parsonstown	−0·8	−0·1	−0·8	−0·3	—	No spare ther.
Valencia	−1·1	−0·7	−0·3	+0·2	−0·2	
Roche's Point	−0·7	−0·7	−0·4	+0·2	—	No spare ther.
St. Ann's Head	−0·2	−0·5	+0·2	−0·5	−0·3	
Malin Head not inspected this year.						
Weekly Weather Report Stations.						
Killarney	−0·2	−0·2	0·0	0·0	—	
Waterford	−0·7	−0·8	−0·2	0·0	—	
Feynes	—	—	−0·2	+0·2	—	
Londonderry, Kilkenny, and Llandovery not inspected this year.						

(Signed) Robert H. Scott.

Report of Inspection—Scotland.

Barometers.—During August the inspection of the barometers did not include a comparison with the standard mercurial barometer. This comparison was made as regards the last 12 stations inspected, which is inclusive of six barometers not previously reported on to the Council. From the direct and indirect comparisons made, I am able to report that the whole of the barometers specified in the annexed table are correct, allowance for instrumental errors being made, are in good order, and the observations accurately made.

Table I.

Stations.	Inspector's Standard, No. corrected.	Rep. Baro. uncorrected.	Check Baro. uncorrected.	Remarks.
	ins.	ins.	ins.	
Laudale	—	30·248	30·242	Check barometer is 8 feet higher.
Fort William	—	30·208	—	
Fort Augustus	—	29·774	—	
Glencarron	—	29·130	—	
Lairg	—	28·835	—	
Dunrobin	—	29·120	—	
Wick	—	29·114	—	Standard mercurial barometer not taken this year to these stations.
Swanbister	—	29·776	—	
Stornoway	—	29·800	29·800	
Nairn	—	29·648	29·648	
Gordon Castle	—	29·486	—	
Aberdeen	—	29·173	29·170	Check is standard of observatory.
Braemar	—	28·200	28·180	Do. old bar. now out of order.
Lednathie	—	29·189	—	
Dundee	—	29·985	—	
Callton Mor	29·935	29·900	—	
Rothesay	29·954	29·958	—	
Ardrossan	29·893	29·888	29·854	Check barometer in Mr. M.'s house.
Glasgow	30·028	30·030	—	
Clober (Milngavie)	29·718	29·694	—	
Ochtertyre	29·680	29·670	—	
Hawick	29·462	29·462	—	
Wolfelee	28·800	28·800	—	
Marchmont	29·676	29·676	—	
Edinburgh	30·039	30·062	—	Check is a Redier's barometer.
Leith	30·480	30·486	—	
Rosewell	29·643	29·638	—	

Thermometers.—The minimum thermometers were this year again very specially examined, but with a result scarcely so satisfactory as last year. The following were out of order: At Wick about 4°·0 were lodged near the top of the tube. A comparison of the past readings will show how long this thermometer had been out of order. At Rothesay a minute portion of spirit, about 0°·3, was lodged at the very top of the tube. At Leith 1°·8 of the spirit was lodged at the top of the tube. This was discovered by the observer about five months ago, who since then has regularly added fully a degree and a half to each reading. All these thermometers were rectified.

New minimum thermometers have been supplied to Dunrossness and Nairn.

TABLE II.

Stations.	Standard No. 4,133, corrected.	Dry Bulb.	Wet Bulb.	Spare Thermometer.	Max. Thermometer.	Min. Thermometer.	Time in Water in Minutes.	Change of Temperature.	Remarks.
	°	°	°	°	°	°		°	
Laudale -	60·4	+0·2	+0·2	—	+0·2	+0·3	150	+0·4	C. Livingston observer
Fort William.	63·1	−0·1	+0·1	—	+0·1	−0·3	60	+0·4	
The Observatory, F.W.	63·9	+0·1	+0·1	—	0·0	−0·1	90	+0·5	
Fort Augustus	58·8	+0·1	+0·1	—	+0·1	−0·4	80	Uniform	
Glencarron-	55·7	0·0	−0·2	—	0·0	−0·2	100	+0·3	
Lairg - -	57·8	+0·2	+0·1	—	−0·3	0·0	70	+0·2	
Dunrobin -	60·0	−0·5	−0·4	—	—	−0·6	75	Uniform	Index of Max. T. lost.
Wick - -	58·7	+0·5	+0·4	—	−0·3	—	60	Do.	
Stornoway -	55·9	+0·5	+0·5	—	+0·7	−0·4	90	Do.	Min. T. was 4° out of order.
Nairn - -	54·5	+0·7	+0·6	+0·1	0·0	−0·1	90	Do.	
Gordon Cas	57·0	+0·1	+0·2	—	+0·5	+0·1	120	+0·7	
Aberdeen -	57·2	+0·2	+0·2	—	+0·1	+0·1	75	−0·2	
Braemar -	54·7	+0·4	+0·5	—	+0·2	0·0	90	+0·3	
Lednathie -	51·9	+0·2	0·0	—	+0·2	−0·1	100	Uniform	
Dundee -	52·6	+0·5	+0·4	—	+1·4	−0·3	60	Do.	
Callton Mor	59·6	+0·1	0·0	—	+0·8	−0·5	60	−0·3	
Rothesay -	56·0	0·0	0·0	—	+0·2	−0·4	65	Uniform	
Ardrossan -	54·7	+0·2	+0·3	—	−0·2	−0·2	80	−0·2	
Glasgow -	55·8	—	—	—	−0·2	−0·1	50	+0·2	
Clober -	55·7	−0·1	+0·1	—	+0·5	+0·1	75	Uniform	
Ochtertyre -	53·8	0·0	0·0	—	+0·1	0·0	70	Do.	
Hawick -	59·2	0·0	−0·1	—	−0·1	+1·0	80	+0·3	
Wolfelee -	53·0	−0·2	−0·2	—	+0·2	−0·5	120	−0·3	
Marchmont	53·4	−0·1	−0·1	—	0·0	−0·1	300	Uniform	Temp. practically uniform.
Edinburgh-	52·7	−0·1	0·0	—	0·0	0·0	85	Do.	
Leith - -	52·5	+0·2	+0·4	—	+0·2	−0·4	50	Do.	

HYGROMETERS.

I have to report very favourably regarding the care with which the wet-bulb thermometer is attended to at all the stations without exception. While inspecting the station at Rothesay the weather was dull and drizzling, the air being apparently filled with the fine drizzle, the dry and wet bulbs in the screen read exactly the same. This is the first occasion I have seen this correspondence to occur since it was begun, some years ago, to give special attention to the working of the hygrometer in the thermometer screen.

Laudale, August 7, 1890.—There has been some trouble at this station from the index portion of the column of the maximum thermometer being shaken from its position during high winds. Accordingly, since last inspection, four new wooden supports and four new wire stays have been added to the Stevenson screen, which is now very firmly fixed, and it is believed the index now retains its place in high winds.

The instruments were all in very good order, and the observations are carefully made.

Fort William, August 9th.—The instruments were in good order, and the observations are correctly made. It has been resolved that the observations at this station, inclusive of those recorded by barograph and thermograph, be continued for some time till a satisfactory comparison be made between them and the observations made at the new observatory.

The Observatory, Fort William, August 8–9.—This observatory has been equipped as a station of the First Order by the Meteorological Council, and as a station of the Second Order by the Scottish Meteorological Society. Both sets of observations are forwarded to the Meteorological Office.

The Stevenson screen, rain-gauge, and sunshine recorder are placed in an open situation over grass, on which the sun shines all day from one hour after sunrise to sunset in summer, and the whole day in winter. There are three rain-gauges, Beckley's, with its accompanying check gauge, and one of the type in use at the Ben Nevis Observatory.

The self-recording instruments furnished by the Council have been recently fitted up by Mr. Baker, of the Kew Observatory, and the regular observations commenced on July 14th.

Everything at the observatory was in excellent order, and the observations were made with the greatest care and punctuality.

The Abbey, Fort Augustus, August 11.—The instruments were all in excellent order and are particularly well attended to and observed by Father Cody, the new observer. The sun reaches the sunshine recorder all day, except when it is behind the mountains, which here form a very irregularly outlined horizon.

Glencarron, August 14.—All the instruments were in very good order, and are observed with scrupulous accuracy. A Richard's hygrograph has just been added to this station and is placed in the same Stevenson screen with the thermograph.

Lairg, August 14–15.—The thermometer screen has been furnished with a new stand, been repainted, and thoroughly repaired. A new rain-gauge has been sent since the date of inspection, viz., on October 8th. The instruments were otherwise in good order and are well observed.

Dunrobin, August 15.—The index of the maximum thermometer (Phillips') was inadvertently lost at the time of the inspection. A new thermometer was sometime after sent from Edinburgh. All the other instruments were in good order, and are carefully observed.

Wick, August 15.—The minimum thermometer was seriously out of order, a part of the spirit, about 4°·0, being lodged near the top of the tube. This was shaken down. On comparison with the standard, as it still read 0°·7 too low, it was ordered to be placed in a highly inclined position for some hours before being replaced in the screen, to allow time for the whole of the spirit to drain down. Subsequent readings show that it is now correct. The other instruments were in good order, and are very well observed.

Swanbister and Stenness, August 18.—At the time of Mr. Fortescue's removal from Swanbister, the instruments were handed over to Mr. W. Halcro, joiner, who had been one of the assistant observers. He made the observations regularly and forwarded them to Mr. Fortescue for entry on the monthly schedules. Here the temporary positions of the instruments were good, but the maximum thermometer had been

accidentally broken in the end of last year, of which no intimation was given. (A new one was forwarded on my return to Edinburgh in October.) Thereafter I drove to the station at Stenness, taking the barometer with me, and placing it in its new position, and arranged with Mr. Fortescue, who kindly accompanied me, and with Mr. Spence, the new observer, for the immediate removal of the rest of the instruments to Stenness, and the positions in which they were to be placed. The situation of Stenness is a very open one, and Mr. Spence is likely to prove a good intelligent observer.

Stornoway, August 20.—Particular attention was given to the omission from the daily telegram of July 25th of any notice of the rapid fall of the barometer and storm during the previous night, for which Mr. Forbes expressed great regret. He made no attempt to account for the neglect, but he is unable to understand how it did occur. I believe the effect will be to make him thoroughly alert in future against the recurrence of so serious an omission. The rain-gauge was slightly deformed, but it was made right. The glass measure was broken accidentally on the Saturday. What remains still measures 0·3 inch, and will be used till a new measure arrives. All the other instruments were in excellent order and are well observed

Nairn, August 22.—The instruments were all in good order and intelligently observed, and the telegrams made up with care and expertness. The new minimum thermometer was hung up and the old one packed in the box and ordered to be despatched to the Office.

Gordon Castle, August 23.—Mr. John Webster, who had observed nearly 40 years, died last Christmas, and has been succeeded by his son Charles as head gardener and observer. The instruments are well exposed and placed in the kitchen garden, and were all in excellent order, and observed with great care and accuracy.

Aberdeen, August 26.—Everything at this station is well attended to, and the observations are made with remarkable care and intelligence.

The same remark applies to the self-recording instruments of the observatory. At the time of the inspection the "drop" from the wet-bulb fell at the rate of one in a minute and a half. As at the Fort William Observatory, the rain-gauge, after being emptied, does not begin to register till 0·005 inch of rain has fallen. It was satisfactory to observe from an examination of the curves, as showing the state of efficiency of the anemometer, that changes of wind were quickly shown with such small velocities as a rate of from 2 to 3 miles an hour.

Braemar, August 27.—As indicated in last Report, a new set of instruments has been supplied by Her Majesty to this station to replace those in use since 1855, and the screen in which they are kept has been thoroughly repaired and painted. They are superior instruments, kept in excellent order, and are well observed by Mr. Aitken and his niece.

Lednathie, August 29.—Everything at this station was in very good order, and the observations are made with remarkable intelligence. The vane works well except during frost, but in all cases its indications are checked by observations of smoke, trees, &c. The station is well up the slope of the Lednathie Burn, a tributary of the Prosen. The situation in the valley gives necessarily an undue proportion of N.W. and S.E. winds.

Dundee, August 30.—The instruments here continue to be thoroughly well kept, and the observations accurately made.

Callton Mor, September 1.—The instruments were in very good order, and are observed with much care and intelligence by Mr. Russell and assistant. As the index of the maximum thermometer (Phillips') was too long, it has since the time of inspection been sent to Edinburgh for rectification. This station was established in 1855, with the same observer, and with substantially the same instruments throughout. The instruments are placed in a very open situation in the garden.

Rothesay, September 2.—A comparison of the minimum thermometer with the standard suggested an examination, when a minute portion of spirit (about 0°·3) was seen lodged at the top of the tube. This was rectified. With this exception, the instruments were all in thoroughly good order, and observed with great intelligence.

Ardrossan, October 1.—The rain-gauge and thermometer screen are repaired and repainted, both jobs being well and strongly done. All the instruments now are in good order, and the observations are made with considerable intelligence.

Glasgow Observatory, October 2.—Except the 5 inches rain-gauge which has been raised to 16 inches above the ground, all the instruments remained as they were at the time of last inspection; they were all in very good order.

Milngavie, October 3.—The instruments at this station were in good order, and are intelligently observed and attended to. The anemometer is in a good position on a knoll in a field about a quarter mile from the other instruments.

For the sake of securing uniformity with the other stations of the Office, a Stevenson's thermometer screen was recommended, and it was also recommended that the barometer be removed from the large thermometer screen to the office adjoining. These suggestions have since been carried out. Mr. Bertram is very desirous in establishing this station that everything be in accordance with the requirements of the Office; and doubtless in his hands the station will become a valuable addition to the system.

Ochtertyre, October 4.—Everything at this station was in excellent order, and the observations are made most intelligently.

Ladylaw, Hawick, October 14.—The instruments are very good, and the observations, which began at the New Year, are intelligently and accurately made.

Wolfelee, October 15.—Instructions were given to paint the Stevenson screen and the rain-gauge. As regards the other instruments, they are good, were in good order, and the observations made with great care. The observer showed a good deal of interest in the observations, and a strong desire to do all in his power to make them correctly.

Marchmont, October 18.—The instruments are all in excellent order, and the observations made with marked intelligence. Mr. Loney has a good assortment of additional instruments at this station.

Edinburgh, October 21.—In addition to the usual instruments, which are nearly all in duplicate, Mr. Moss has a Redier's barograph, a Richard's thermograph, a Robinson's anemometer, and a sunshine recorder. The whole of the instruments are in remarkably good order, well placed, and are observed with much intelligence and enthusiasm.

Leith, October 22.—The minimum thermometer was found with 1°·8 of the spirit lodged near the top of the tube, which the observer, under my direction, set right. This was discovered by the observer five

months ago, and since then the readings have been regularly increased by adding 1·5 degree. Otherwise the instruments were in very good order, and the observations very intelligently made. Since last inspection the thermometer screen and enclosure has been repaired in a very satisfactory manner.

Rosewell, October 23.—The instruments are all good, and are well protected in a railed-off grass plot. They are in good order, and are attended to and observed with great care and intelligence.

(Signed) ALEXANDER BUCHAN.

REPORT of INSPECTION—ENGLAND.

TELEGRAPHIC REPORTING STATIONS.

Scilly (*St. Mary's*), June 26 and 27. — Since the death of Mr. Thomas, which occurred in the early part of the year, and by which the Council have been deprived of an observer of long experience, Mr. A. Hicks has undertaken the charge of the instruments at this station. I have in previous years given him some instruction, and have recommended him as being probably the only man in the island at present capable of undertaking the work of observation. I found him to require further teaching as regards the reporting of important changes indicated by the self-registering aneroid, and also as to the setting of the verniers of the barometers, which he had lowered too much (the error thus caused having been about − ·026 in.). He has also a slight personal error in reading both barometers and thermometers, which appeared to me to be constant and unimportant.

All the instruments at Scilly are in their old positions, and in good order, except that a part of the anemometer again required cleaning, and that the maximum thermometer is very difficult to set, and should therefore be exchanged for another. I think that the present observer's estimates of wind forces of "5" and upwards, will be found to be slightly lower, in the mean, than were the estimates made by Mr. Thomas.

Prawle Point, June 29. — I found the observer at this station, Mr. Hewitt, to read the instruments, as before, with accuracy; but some loss has been sustained by the departure of Mr. Mehegan. Mr. Hewitt will probably be himself removed from Prawle in a short time. Another of the men at this station, Mr. Macarthy, appeared to me to be an intelligent and careful observer. The station is an excellent one, but the frequent changes of *personnel*, common to all coastguard stations, naturally form an obstacle to perfection in the observations. The observers at the time of my visit showed some aptitude for cirrus observations; they had, however, failed to report important changes of weather occurring between the fixed hours of observation. The instruments were in good order, but the maximum reads somewhat low.

Hurst Castle, July 2.—The instruments at this station were found to be in a satisfactory condition. The reports of the barometer and of the highest temperature show, as in former years, occasional errors. These are certainly not due to any inability to read the instruments correctly on the part of Mr. Appleton, but he has a somewhat hasty and casual way both of handling the instruments and taking the readings, and this appears to be ineradicable. Both the winds and the state of the sea are, as I have previously remarked, affected by local causes at this station.

Dungeness, July 31.—Mr. Curnow has left this station, and the observations are chiefly conducted by Mr. Batten. Inaccuracies still appear to occur from time to time in the barometric reports; but in my presence the light-keepers, who, as formerly mentioned, take the readings in rotation, as they are on duty, certainly read the instruments well, and all those now at the lighthouse give me the impression of being sober and reliable men. The muslin of the wet-bulb had not been changed with sufficient frequency.

Yarmouth, August 2–3.—The instruments at this station are in good order; but the wet-bulb is not kept sufficiently clean. The tracings of the self-registering aneroid have for a long time been too thick, in consequence of Mr. Watson's having attempted to alter the working of the pen, in order, as he told me, to "prevent the jumpings" produced in its trace. I accidentally broke off the ink-holder altogether in opening the case, which has no hinge, and was unclamped on the right-hand side. The pen has since been repaired, and the aneroid tracings are now good.

Cambridge, August 4.—Mr. Todd was again absent from Cambridge on the day of my visit. The reports have occasionally arrived late from this station. In reply to a letter on this subject, I was informed by Mr. Todd that they were in each case handed in punctually at the telegraph office. The fault lay with the latter, and the reports now arrive punctually. The alterations made in the height of the anemometer appear to me to be very advantageous. The dome of the observatory used formerly to obstruct Southerly, and to a less extent Northerly winds, in a very appreciable degree, and the obstruction is now less serious.

The observatory is, however, considerably sheltered by trees, and, as will be noticed from the horizon-breaks in the altazimuth sketch, these trees cut off the sun's rays from the sunshine recorder in the mornings of the late autumn and the beginning of the year. The observer states that he considers that, upon the average, not more than 30 minutes are lost by reason of the trees.

I found the instruments to be all in good condition, except that there was some deposit on the wet bulb.

Loughborough, October 9.—The observer was absent until very shortly before I left the station. Both the barometer and all the thermometers were found to be perfectly correct, and all the instruments to be attended to, as usual, with the very greatest care.

York, October 12.—The barometric reports from this station have not appeared to be quite satisfactory, the errors being usually positive. Some of the mistakes may be due to the want of punctuality on the part of the observer, of which I have formerly complained. On the occasion of this visit, however, the observer, to my surprise, set the vernier as much as ·018 too high. On my calling his attention to the mistake, he immediately set the vernier correctly. The thermometers are very accurate, but the muslin of the wet-bulb is not changed as frequently as the atmosphere of York requires.

Shields.—I visited North Shields on October 13. The barometers were removed from the old post office buildings to the telephone room of the new buildings on February 21st, 1890. Here their position is excellent, possessing several advantages which were wanting in their former site. The height of the cisterns, obtained from the builder's plan, is 117 feet above mean sea level. The muslin of the hygrometer had not been changed on the Saturday before my Monday's visit, the day of

the week on which it is said to be usually changed. It was more foul than usual, and in the extremely smoky air of Shields a daily change would be requisite to ensure anything like freedom from dirt. The rain-gauge as previously reported, receives occasional injuries, the inhabitants of the houses round Dockwray Square, with a considerable number of children, having access to it. The instruments are otherwise in good order.

STATIONS SUPPLYING MONTHLY OR WEEKLY RETURNS.

Cirencester, July 3.—Professor Ohm was engaged during almost the whole of my visit, and I only obtained one or two minutes conversation with him between his lectures. The instruments are in good order. The thermometers are well mounted in an enclosure made for that purpose in the large vegetable garden on the north-west side of the College; their readings are very correct. The sunshine recorder is well mounted on the top of a large and firm stand, reached by a ladder, and its adjustments are correct. It will be seen by the altazimuth sketch, which I have sent to the Office, that sunshine is cut off during the summer solstice between 7.25 and 7.32 p.m., or thereabouts, by a dense and growing clump of trees. Trees must also slightly interfere with the sunshine in winter, both in the morning and afternoon. The instrument was shifted to its present position in the autumn of 1888. It previously occupied an excellent vantage ground at the summit of the College tower, which had to be relinquished at the orders of the Principal on account of mischief done by some of the students, who seem to have gained access to the tower.

Epsom, July 30.—The observer was absent throughout the afternoon. The assistant was unfamiliar with the proper mode of treating the wet-bulb during frost, and I gave instructions on this subject. He read the instruments correctly. The muslin round the wet-bulb was somewhat stiff with lime and copper salts. The max. read 0°·6, or with its usual correction 0°·4, too low. The observations show decided improvement at this useful station.

St. Leonards, August 1.—I regret to say that I have not changed my opinion that Mr. Colborne is not a painstaking observer. He was absent from home on the day of my visit. The thermometer screen in the Gensing gardens required repairs, and it is rather surprising that the instruments remain unbroken, considering that they are accessible to the public. As it is, the minimum had disappeared, and had been replaced by the grass thermometer, which was simply laid on the bottom of the screen. I could not obtain the corrections for the thermometers; as compared with my standards the wet-bulb required a correction of −0°·5.

The sunshine recorder, which has a good exposure at the Hastings reservoir, is attended to by the keeper of the reservoir. I could not obtain access to the instrument on the day of my visit this year.

Eastbourne, August 1.—The returns from this station continue to be satisfactory. The instruments are in excellent order. The observer attaches no muslin to the wet-bulb, but winds the wet thread of wick round the bulb. I think that it may be best to permit him to adhere to this custom.

From the altazimuth sketch which I took at the sunshine recorder it is evident that the evening sun is cut off, principally in winter, by the range of high land, the southern extremity of which forms Beachy Head. The instrument has in other respects a perfect exposure, and the cards are carefully attended to.

A new copper rain-gauge is greatly needed at this station, the old instrument being almost entirely worn out.

Market Rasen, Tealby Vicarage, October 10.—Since Mr. Jevons relinquished the observations at Market Rasen the instruments, with the exception of the rain-gauge, were removed by the Reverend S. Lewin to his house at Tealby, about four miles north-east of their former position. Mr. Lewin, who required some instruction in the work of observation, was necessarily absent during a considerable portion of my visit. Levelling from an O. S. mark, I found the barometer cistern to be 260·1 foot above M. S. L. The instrument, which is fastened into its wooden box, was not suspended in a satisfactory way. The thermometer screen requires some repair and repainting. I could find no convenient site for a rain-gauge.

That the observer will fill in the returns conscientiously and punctually to the best of his ability I have no doubt. Unfortunately not only are the instruments rather inconveniently placed (and there seems to be no chance of improving their position here), but the whole locality is so much obstructed by trees and buildings and characterised by such hilly and broken ground, that I hesitate to give an opinion as to its suitability, desirable as it is that some station should be found in this neighbourhood. I should recommend that a few months' trial of the station be made, rainfall reports being had if possible from Mr. Jevons.

I have sent a rough ground plan of the position of the instruments.

York, October 12th.—The instruments at the Museum Gardens are in good order, and the observer reads the thermometers with accuracy, though he appears to be careless with his barometer. The screen is too crowded with instruments, the difference between the readings of which, when the door is closed, well exemplifies the effect of raising or lowering a thermometer-bulb in a Stevenson's screen.

The sunshine recorder was well adjusted at the date of my visit. The question whether it should be removed from the Friends School at Bootham should, in my opinion, be definitely decided in the negative. Mr. Clarke is a most able scientific teacher. The exposure at Mr. Thompson's house would not, I think, be so good, although that at Bootham is rendered imperfect by the Minster tower, an immovable obstacle, and by chimneys. Further, although the wooden pedestal on which the instrument is erected is unsteady, the school authorities are not disposed to go to the expense of erecting anything more substantial, and although it is difficult to get the instrument thoroughly well attended to in the vacations, and in term time some carelessness may be expected in the boys who occasionally have the charge of it, it is to be remembered that much is to be gained by the keeping of scientific instruments at educational establishments.

While it is easy to estimate a small present loss due to occasional clumsy manipulation, it is difficult to set too high a value on the possible acquisition of a taste for meteorological observation at our schools, and at such institutions as Epsom College, Cirencester, Cooper's Hill, &c. And if I may here be permitted such a digression, I think that the downward percolation of science is so great, that one lecture at a public school is worth very many at a fishery station.

Seaham, October 13.—The barometer was moved October 11, 1889 (since last year's inspection), from its rather inconvenient position in Mr. Aird's house to a good site in the residence of Mr. Leith at the cemetery grounds. The observations are all taken by Mr. Leith, who seemed inclined to set the vernier of the barometer somewhat low, but is accurate and careful in his readings of the thermometers. All corrections and reductions are still made by Mr. Aird, with whom I had no

interview on the day of my visit, as he was absent at his new residence, about six miles from the station. As might perhaps be expected, some inaccuracies have been noticeable in the returns. The max. read 1° too low. The screen has been repaired and repainted. All the instruments were found to be in good order. The present level of the barometer cistern is given as 150 feet. I question whether this is not 1 or 2 feet too high.

Stokesay, October 17.—The barometric returns from this station have for a long period been questionable. All the instruments are usually read carefully, as I think, by Miss La Touche, but at times the readings are taken by some of Mr. La Touche's young pupils, and I think that the barometer may occasionally be handled with insufficient care. I dislodged a small bubble of air from the tube, but after this had been done the mercury appeared to stand ·027 too low. The thermometer screen is home-made and of peculiar but not unsatisfactory type. I requested that it should be repainted and have some slight necessary repairs. I also advised that the grass minimum, which is new, but out of order, should be exchanged for another instrument. A good solar radiation thermometer is in use here now. As I have formerly observed, the wind at this station is very greatly affected by the hills.

Sutton Coldfield, October 18.—Since my last inspection the thermometer screen and rain-gauge have been removed to the observer's garden, where they have a satisfactory position. The barometer, an instrument on the Fortin principle, is by Bailley, of Birmingham, and has no error throughout the scale. It has not been removed from its former position on the ground floor of the borough offices. All the instruments are in good order, and appear to be well attended to, but some inaccuracies and omissions have been observed in the returns. I think improvement may be expected.

I inspected the following FISHERY BAROMETER STATIONS, with rather disappointing results :—

Hull.—I examined the fishery barometer at noon of October 11th. The number of this instrument, which was supplied in 1853, is B.T. 17. The level of the cistern is 7 feet above M.S.L. I found the instrument (at 30·270) to have a somewhat large error, requiring the correction of +·074, but the tube to contain no air. The foreman at the Humber Dock is in charge of the instrument, which he reads fairly correctly, but does not understand. The readings are sent in daily to the principal dockmaster's office, but are, as I was told, made no further use of. I think that the instrument attracts but little attention, except from a stray loiterer at the docks.

Withernsea.—I had selected Saturday as the most convenient day for lecturing to the fishermen at this station, and had written to Mr. John Ward, who is in charge of the instrument, on the subject. On my arrival, however, I found that there are only ten fishermen here, all of whom had gone to a fair at Hull. The barometer, B.T. 76, which was supplied in 1863, is affixed to the outside wall of what was formerly Mr. Ward's shop. I examined the instrument at 3 p.m. of the 11th, and found it, with a reading of 30·179, to require a correction of +·017. The instrument, however, appeared to be free from air. The altitude of the cistern was given to me by Mr. Ward as 20 feet above M.S.L., but, having plenty of time, I levelled and found it to be 22·3 feet. I could not elicit from Mr. Ward any tokens of intelligence as to the use of the instrument, neither do I think that the fishermen at this desolate spot employ it much.

(Signed) W. CLEMENT LEY.

October 21, 1890.

STATION. Name of Station.	BARO-METER. Difference of Observer's from Inspector's Readings.	THERMOMETERS. Temperature of Water.	Dry Bulb. Correction to reduce to Inspector's Standard.	Dry Bulb. Correction hitherto applied.	Wet Bulb. Correction to reduce to Inspector's Standard.	Wet Bulb. Correction hitherto applied.	Maximum. Correction to reduce to Inspector's Standard.	Maximum. Correction hitherto applied.	Minimum. Correction to reduce to Inspector's Standard.	Minimum. Correction hitherto applied.	Spare. Correction to reduce to Inspector's Standard.	Spare. Correction hitherto applied.	Grass. Correction to reduce to Inspector's Standard.	Grass. Correction hitherto applied.	Grass. Condition of Hygrometer.	STATION. General State of Station.	Name of Station.
			°	°	°	°	°	°	°	°	°	°	°				
Cambridge	−·003	64	−0·1	—	0·0	—	−0·4	—	+0·5	—	—	—	—	—	B	A	*Cambridge.*
Cirencester	—	60	+0·1	—	0·0	—	−0·1	—	−0·1	—	—	—	0·0	—	B	A	Cirencester.
Dungeness	+·001	60	0·0	—	+0·1	—	0·0	—	−0·1	—	—	—	—	—	B	A	*Dungeness.*
Eastbourne	—	70	0·0	—	+0·1	—	+0·1	—	0·0	—	—	—	—	—	A	A	Eastbourne.
Epsom	−·002	57	−0·25	−0·1	−0·1	—	+0·6	+0·2	+0·4	—	—	—	+0·35	—	A	A	Epsom.
Hurst Castle	·000	59	−0·15	—	−0·25	—	−0·15	—	−0·3	—	—	—	—	—	A	A	*Hurst Castle.*
Loughborough	—	55	+0·05	—	0·0	—	0·0	—	+0·05	—	+0·05	—	—	—	A	A	*Loughborough.*
Market Rasen	−·002	53	+0·1	—	−0·1	—	−0·4	—	+0·7	—	+0·4	—	—	—	B	C	Market Rasen.
Prawle Point	−·002	58	−0·1	—	0·0	—	+0·2	—	+0·4	—	+0·1	—	—	—	A	A	*Prawle Point.*
St. Leonards	—	66	−0·2	—	−0·5	—	0·0	—	—	—	—	—	+0·4	—	B	C	St. Leonards.
Scilly	−·020	55	0·0	—	0·0	—	−0·7	—	+0·2	—	0·0	—	—	—	A	A	*Scilly.*
Seaham	−·002	55	0·0	—	0·0	—	+1·0	+0·5†	0·0	—	—	—	—	—	A	A	Seaham.
Shields	+·002	57	0·0	—	0·0	—	−0·2	—	+0·1	—	—	—	—	—	B	A	*Shields.*
Stokesay	+·001	53	+0·1	−0·1	−0·2	−0·4	−0·1	−0·3	+0·3	−0·3	—	—	—	—	B	B	Stokesay.
Sutton Coldfield	+·004	—	—	—	—	—	—	—	—	—	—	—	—	—	B	B	Sutton Coldfield.
Yarmouth	−·001	66	−0·35	—	−0·05	—	+0·15	—	+0·35	—	—	—	—	—	B	A	*Yarmouth.*
York	+·018	58	0·0	—	0·0	—	−0·2	—	+0·2	—	—	—	—	—	B	B	*York.*
York	+·018	58	0·0	—	0·0	—	+0·1	—	+0·4	—	—	—	—	—	B	B	York.

REPORT on INSPECTIONS of the SELF-RECORDING OBSERVATORIES and ANEMOGRAPH STATIONS.

(M.O. 2119.)

Stonyhurst Observatory was inspected on August 14, 1890.

The instruments were found in good order, the barograph lenses were cleaned, although found to be much discoloured with fungoid growth between them, and the clocks were oiled. The thermograph calls for no note, beyond the fact that the wet-bulb threads required to be replaced by new ones, which was done.

The anemograph was in want of cleaning and oiling; it was accordingly wiped and oil applied. The joints in the long shafts have very considerable play, but that could not be rectified without fitting new screws. The rain-gauge was in very good order, but the pencil in use seemed to be coarser than is usually employed.

The sunshine recorder was in good order.

At the time of the inspection the two senior assistants were absent on account of illness, and the routine work was being carried on by a lad under the superintendence of the Rev. W. Sidgreaves.

Comparisons of thermometers were made as follows, Kew Standard of reference, K.S. No. 682 being used:—

Corrections to	Dry, K.S. 619 - - - -	−0°·2
„	Wet, K.S. 382 - - - -	−0·5
„	Bar. Ther., K.S. 339 - - -	−0·5
„	Max., M.O. 439 - - -	−0·3
„	Min., B.T. 501 - - -	+0·3

Aberdeen Observatory, visited August 2, 1890.—All the instruments were found duly working in good order. Lenses, &c. were cleaned and clocks oiled. No repairs were required. Owing to inclement weather the anemograph could not be entirely dismounted, but the bearings were all examined, and being found in good order were freshly oiled throughout. The sunshine recorder examination is registered on the printed form. The comparison of the thermometers was made in pounded ice, the results being entered in appended table:—

Dry, K.S. 397 - - - - -	−0°·05
Wet, K.S. 395 - - - - -	−0·6
Max., M.O. 1,002 - - - - -	0·0
Min., 5,056 - - - - - -	−0·1
Bar. Std., K.O. 71,061 - - - -	−0·4

Glasgow, Observatory, visited August 18, 1890.—The barograph, thermograph, and rain-gauge were all found to be working in good order. The lenses were cleaned and clocks oiled. The thermometers were compared with the inspector's standard, with the result given in the appended table. The anemograph was cleaned and examined, all the bearings being found in good order and the shafts sound. A blade of one direction fan being loose, it was carefully soldered up and set right. The sunshine recorder was also examined. The corrections to the thermometers were found to be as follows:—

Dry Std., K.S. 550 - - - - -	−0°·1
Wet Std., K.S. 472 - - - - -	−0·3
Max., 58,846 - - - - -	+0·1
Min., 63,942 - - - - -	−0·1
Bar. Ther. - - - - - -	−0·7

Swanbister, Orkney, visited August 25, 1890.—Mr. Fortescue having removed from this station to a house in Kirkwall, the care of the anemograph, together with the sunshine recorder, had been delegated to a young woman residing about a mile distant, and both instruments were found to have been maintained in thorough order. A new site for the instruments having been selected by Mr. Fortescue and approved by Mr. Buchan, on the hill above Stenness schools, where Mr. Spence, the schoolmaster, had undertaken the duties of observer, the anemograph, its hut and the sunshine recorder with its support, were dismounted and packed upon carts for removal. The next morning these were driven over the hills to the new site, where they were met by the inspector on arrival, with Mr. Fortescue, who kindly gave his assistance in the operation of re-erection. Mr. Spence was on the spot with the necessary workmen, and after marking the ground out with due regard to the proper orientation, foundations were dug and the necessary masonry built up to support the hut. This being done and the external parts of the anemograph being thoroughly cleaned, it was set up, approximately adjusted, and the instrument started by nightfall. The inspector and mechanic drove back to Kirkwall and returned next day, when the recording apparatus was taken to pieces and all, including the clock, thoroughly overhauled, cleaned, and oiled. Compass bearings were then taken of distant objects and the instrument properly adjusted, the observer instructed as to the working and care of it, and the anemograph fairly started in action.

The weather was very inclement and stormy, with heavy rain showers both days, with cloud, so rendering it impossible to adjust the sunshine recorder properly. This operation had therefore to be left in the hands of Mr. Spence, who was instructed how to perform it as soon as opportunity served. The exposure of the site is perfectly free and open on all sides, with the exception of slightly rising ground to the south, which, however, is insufficient to obstruct the solar rays at any time, or materially to influence the wind's force when blowing from that quarter.

The following are the bearings of landmarks from Stenness anemometer:—

N. corrected.—Western extremity of the headland of Ness and Harray and near farm of Brodgar.

E. and S.—Nil.

W. point.—Garden on farm of Marcequoi cairsto.

Fleetwood.—The anemograph at this station was inspected on August 11th–13th. The instrument was found working properly and well kept. Both shafts were taken out, and when cleaned of corrosion, small cracks were found in both shafts, which I had soldered up by a smith before replacing them. The direction fans were found free in their action, but their pitch is apparently coarser than in the case of other instruments, hence the diminished oscillation usually recorded. The loose blades on the fans were soldered up, and the nut on the clamping screw of the clock, which was found loose, was made tight. The orientation was examined and re-adjusted by a compass. At the request of Mr. Gaulter, I looked out a suitable spot for placing the sunshine recorder, should the town commissioners decide upon purchasing such an instrument. From the south side of the pavilion a perfectly clear horizon could be obtained for about 300° from NNE. to NNW.

North Shields.—Visited the high lighthouse to inspect the anemograph September 5th–6th. Found it working in good order; cleaned the whole thoroughly, and examined the shafts. These were not split,

but the Hook's joints appear somewhat slack. Oriented vane anew from sun's observation.

Yarmouth, September 11–12.—The anemograph at the Sailor's Home was thoroughly examined and cleaned, the shafts being also tested and found sound. A joint in the velocity shaft had worked loose and was screwed up tight. The clock was taken down, cleaned, and freshly oiled. The Hook's joints are all loose from wear. The orientation was tested by sun, and instructions given to Mr. Watson to set for N. about half a compass point further to the east than he had been in the habit of doing when checking the direction in future.

(Signed) G. M. WHIPPLE.

(M.O. 2120.)

Radcliffe Observatory, Oxford, October 1.—The whole of the instruments here were in a satisfactory condition and call for no special remark. The sunshine recorder is very well placed on the tower of the observatory about 100 feet above the ground, and has an uninterrupted exposure all the year through. Further details are given on the special form which accompanies this report.

A comparison of the various thermometers in use with the Kew standard thermometer No. 682 was made by me with the following results at 62° :—

Correction to standard dry bulb, No. 576 - -	−0°·1
„ „ „ wet „ No. 575 - -	−0·2
„ „ maximum, M.O. 356 - - -	−0·5
„ „ minimum, M.O. 363 - - -	−0·1
„ „ barograph thermometer - -	−0·2

The instruments placed in the Stevenson's screen were also examined as follows at 62° :—

Correction to dry bulb, B.T. 1,710 - - -	−0°·3
„ „ wet „ „ 1,709 - - -	−0·3

Holyhead, visited October 2–3.—At this station the anemograph was found in excellent working order, and as usual is well attended to. Unfortunately at the time of my visit the wind was blowing hard so that it was impracticable to dismount the exterior portions of the instrument.

The bearings, however, were examined and the orientation duly tested.

My attention was called to the unsatisfactory state of the clips which fasten the paper to the cylinder; these were put right before leaving.

Mountjoy Barracks, October 4.—Here the anemograph was in want of cleaning, the oil in the direction bearing having become thick and hard. The instrument was accordingly dismounted, the external parts cleaned and fresh oil added. After re-mounting, the orientation was examined.

The clock was taken to pieces and cleaned.

Armagh, visited October 7–8.—On dismounting the anemometer at this observatory it was found that the oil in the direction bearing had become dry and hard. After cleaning all parts of the instrument the bearings were lubricated with mineral oil.

Dr. Dreyer called my attention to the pricker, which worked very stiffly; this was cleaned and set right.

The orientation was examined and found satisfactory.

As regards the rain-gauge the clock was taken to pieces, cleaned, and a new line attached to the weight.

Valencia Observatory, visited October 11–15.—The instruments here were all found to be in excellent order, and the anemometer well oiled and cared for.

The barograph and thermograph clocks were duly cleaned, and the lenses, condensers, and mirrors carefully wiped.

The various thermometers were compared with Kew standard thermometer No. 682, and found to require the following corrections, namely:—

Standard, dry bulb, No. 399	−0°·7
„ wet „ „ 398	−0·5
Maximum, M.O. 1,003	−0·1
Minimum, M.O. 2,497	−0·1
Barograph thermometer	−2·0
Standard barometer, attached thermometer No. K.O. 71,062	−0·1

The external parts of the anemometer were taken down and cleaned, after which all the bearings were lubricated by means of mineral oil. After cleaning the clock the orientation was tested as usual.

The rain-gauge clock was cleaned and the Stonyhurst discharger, which had been removed by Mr. Cullum (previous to my visit), was examined and re-adjusted, and after repeated trials was again fitted to the gauge.

Falmouth Observatory, visited October 20–24.—Everything was found to be working satisfactorily.

The usual cleaning of the barograph and thermograph clocks was duly performed, and the lenses and other parts attended to. A new line was attached to the barograph clock, On looking over the photographic traces, I noticed in the case of the thermograph sheet that it was slightly discoloured by stray light; this was rectified before leaving, and the zero lines shifted from the summer to the winter position.

The thermometers were compared with Kew standard 682, and found to have the following corrections at 62°, namely:—

Dry, Standard 383	−0°·6
Wet, „ 388	−0·3
Maximum, M.O. 104	−0·5
Minimum, M.O. 308	0·0
Barograph thermometer (no number)	−0·8
Standard barometer attached thermometer (no number)	−0·8

As regards the sunshine recorder, this instrument is placed on an iron support, which is fixed to the south railing on the roof of the observatory, the exposure being good all the year round. The adjustment for latitude was not quite right, the trace being a little too low on the card, but this was corrected by means of a wooden wedge.

The anemometer was completely dismounted and all parts cleaned, the bearings afterwards being lubricated with mineral oil.

Two blades of one of the direction vanes were found loose, but these I caused to be soldered tight before again erecting the instrument.

The clock was cleaned and the orientation tested.

The rain-gauge was examined and the clock cleaned.

(Signed) T. W. Baker.

APPENDIX IX.

Method of Dealing with Telegraphic Weather Intelligence.

The operations connected with the preparation and issue of the Forecasts and Storm Warnings have not undergone any material change. The Daily Weather Report also has not been altered in form during the year, but the average monthly values printed therein have been improved by the incorporation in them of the results for the five years 1886–90.

The Office receives, when the telegraphic communications are perfect, fifty-eight reports every morning, seventeen every afternoon (except on Sundays), and twenty-nine each evening, the arrangement of which is explained in the reports for recent years.

At the British and Irish stations the morning observations are taken at 8 a.m. Greenwich time, and most of the telegrams arrive in London at about 9 o'clock, when the Intelligence Department of the Post Office extracts from them the portions required for its wind and weather reports. They are then transmitted to the Meteorological Office by its private wire.

Daily Weather Report.

No important change has been made during the past year in the *form* of the Daily Weather Report, a detailed description of which is given in the Annual Report for 1887. The Report still fills four large quarto pages, and contains on page 1 the whole of the 58 reports from which the maps for the day (given on page 2) are prepared, and the 6 p.m. reports of the previous day, together with the maximum and minimum temperatures of the air, and the rainfall for the previous 24 hours.

On page 2 are two maps, showing (1) for 8 a.m. the distribution of pressure, the prevalent winds, and the sea disturbance, with necessary explanations; (2) the distribution of temperature at 8 a.m., the weather at each station, and the distribution of rainfall during the past 24 hours. Tables are added, giving the means of pressure, temperature, and rainfall as heretofore, but since January 1st the mean values employed have been improved, and are now—

For Pressure,	those for the	20 years	1871–90
„ Temperature	„	20	1871–90
„ Rainfall	„	25	1866–90

Page 3 contains (1) notes on the "General situation at 8 a.m.," and the "Probable changes in system now prevalent;" and (2) the forecasts drawn up at 11 a.m. for each district, relating to the weather likely to be experienced during the 24 hours ending at noon on the day succeeding that of publication; also an explanation of the meaning of the storm signals exhibited on our coasts.

Page 4 contains the observations made at 2 p.m. on the previous day, and "General Remarks on the Weather over Europe during the past 24 hours."

The standing portions of the report (maps, &c.) are printed in blue, while the information for each day is in black.

The subscription for the Report is —

For delivery by hand, where feasible,	£2	*per annum;*
Do. by book post	£1	„

MS. copies of the observations and remarks can be supplied at the rate of 2*l.* 10*s.* per annum. Arrangements can also be made for the supply of charts drawn from the 8h. a.m. or 6h. p.m. observations, such as appear in the "Times."

Correction and Addition List.

The following additional steps are taken to insure accuracy in the Daily Weather Report. Monthly returns are received, from nearly all of the telegraphic reporting stations, of all the observations which have been transmitted to London by wire. These are used for checking the daily telegrams, for the preparation of the average and other values of the different elements, and also as evidence in the case of legal proceedings. A lithographed sheet is issued each month with the Daily Weather Report, containing corrections for all discrepancies which have been discovered, and supplying any observations which have been omitted in the daily reports.

Weekly Weather Report.

The Weekly Weather Report, which has appeared since February 1878, was rearranged at the commencement of 1890, and is now prepared for the calendar week, Sunday to Saturday, in order to bring it into agreement with other weekly publications. This enables it to be published on Thursdays instead of Saturdays. The three daily synchronous maps which it contains (showing the outline of the land and sea) are printed in blue, while the information on them is in black. These maps show (1) for 8 a.m., the temperature, weather, and sea disturbance; and (2) for 8 a.m. and 6 p.m., the distribution of pressure and the winds, over, and on the coasts of, Europe. The information on the first and second pages of each report has been added to, as stated below.

The Summary on the first page contains the average and extreme temperatures, the rainfall values, and the total amount of bright sunshine in each week for twelve districts in Great Britain and Ireland, together with the difference between them and the respective mean values for the corresponding week in previous years. The district values for Accumulated Temperature, Rainfall, and Bright Sunshine are also given, both for the week and for the whole period since the beginning of the year. Two new columns have been added to this Summary, giving the differences between the amounts of sunshine recorded in the week, and corresponding averages in former years in addition to those previously published. The information is derived from observations made at 76 stations, the individual values for which are now given on the second page of the Report.

The tables of Accumulated Temperature are designed to give persons engaged in agriculture better means of estimating the manner in which vegetation is affected by temperature than that afforded by the more usual methods of treating the readings of the thermometer. They show for each week, and for the whole period from the beginning of the year, the weekly and progressive values respectively, of the combined amount and duration of the excess or defect of the air temperature, above or below a suitably fixed standard, or *base temperature*. The base adopted is 42° F., as being nearly equivalent to 6° Cent. which has been considered by continental writers on these subjects to be the critical value, the temperature above which is mainly effectual in starting and maintaining the growth, and in completing the ripening of agricultural crops in a European climate. This base is also convenient as being 10° F. above the freezing point.

Accumulated Temperature is expressed in Day-degrees; a Day-degree signifying 1° F. of excess or defect of temperature above or below 42° F. continued for 24 hours, or any other number of degrees for an inversely proportional number of hours.

An explanation of these rules will be found in the last Annual Report, and full details as to the facts on which the rules are founded are published in Appendix II. to the Quarterly Weather Report for 1878.

The temperature means, derived from the daily maxima and minima, are corrected so as to agree as closely as possible with the true mean daily value, and the average values for the corresponding period in former years have been improved and added to, and are:—

For Temperature	-	-	20 years 1871–90
„ Accumulated Heat		-	10 „ 1881–90
„ Rainfall	-	-	20 „ 1866–85
„ Bright Sunshine	-	-	10 „ 1881–90

The values for temperature, accumulated heat, rainfall, and sunshine for *each station** are given on the second page of each Report, and to this table also two columns have been added giving the difference between the current and average values for bright sunshine.

The Synchronous Charts referred to on page 16, with the daily Remarks thereon, occupy the third to sixth pages.

In addition to the reports from the Telegraphic Reporting Stations, and the returns from the self-recording Observatories, weekly schedules from 43 volunteer observers are used, the names of the stations and observers being as under:—

Names of Stations.	Names of Authorities.
Alnwick Castle - - -	Lieut.-Col. F. Holland, for the Duke of Northumberland, K.G.
Arlington (N. Devon) - -	J. Carter, for Lady Chichester.
Bawtry (Hesley Hall) - -	B. I. Whitaker, J.P., F.R. Met. Soc.
Blackpool - - -	J. Wolstenholme.
Braemar - - -	J. A. Aitken, J.P.
Brookeborough - - -	Mr. Fergusson, for Sir Victor Brooke, Bt., F.L.S.
Cheadle - - -	J. C. Philips.
Churchstoke - - -	P. Wright, F.C.S., F.R. Met. Soc.
Cirencester - - -	The Royal Agricultural College.
Cullompton - -	T. Turner, J.P., F.R. Met. Soc.
Douglas (Isle of Man) - -	A. W. Moore, M.A., J.P.
Dublin - - - -	J. W. Moore, M.D., F.R. Met. Soc.
Durham Observatory - -	H. J. Carpenter.
Edgeworthstown (Currygrane) -	J. M. Wilson, J.P.
Fort Augustus -	The late Rev. E. G. Cody and Rev. A. Weld-Blundell, O.S.B.
Foynes - - - -	W. Ward, for Lord Monteagle, K.P.
Geldeston - - - -	E. T. Dowson, F.R. Met. Soc.
Glencarron - - -	D. D. Munro for Lord McLaren.
Glenlee - - -	W. Melville for C. Maxwell.
Hastings (St. Leonard's) - -	H. Colborne, M.R.C.S.
Hereford - - -	T. A. Chapman, M.D.
Hillington - - -	Rev. H. E. B. Ffolkes, M.A., F.R. Met. Soc.
Kilkenny - - - -	H. Carlton, for the Marquis of Ormonde, K.P.
Killarney - - - -	The Ven. Archdeacon Wynne, F.R. Met. Soc.
Lairg - - -	J. Young, Schoolmaster.
Laudale (Loch Sunart) - -	A. Fletcher, for T. H. G. Newton, M.A., F.R. Met. Soc.
Llandovery - - - -	J. Watkins, F.R. Met. Soc.
Llandudno - - -	J. Nicol, M.D., F.R. Met. Soc.
Londonderry - - -	J. Conroy, F.R. Met. Soc.
Marchmont - - -	P. Loney for Sir Hugh P. Campbell, Bart.

* The sunshine values are furnished for only a limited number of carefully selected stations. See p. 66.

Names of Stations.		Names of Authorities.
Markree Castle (Co. Sligo)	-	A. Marth, F.R.A.S., for Colonel Cooper, F.R.A.S.
Newton Reigny (Penrith)	-	T. G. Benn, F.R. Met. Soc.
Ochtertyre	ℒ	G. Croucher for Sir P. Keith Murray, Bart.
Oswaldkirk (sunshine only)	-	R. Thompson.
Plymouth	-	J. Merrifield, LL.D., F.R.A.S.
Prestwich (Manchester)	-	T. R. H. Clunn, M.D., F.R. Met. Soc.
Rothamsted	-	Rainfall by Sir J. B. Lawes, Bart., LL.D., F.R.S., and J. H. Gilbert, Ph.D., F.R.S.; temperature by T. Wilson, F.R. Met. Soc.
Scarborough	ℳ	W. Robinson.
Southampton	-	J. T. Cook, R.E., Ordnance Survey Office.
Stamford (Ketton Hall)*	-	Fred. Coventry.
Stowell	ℳ	Rev. H. J. Poole, F.R. Met. Soc.
Strathfield Turgiss	ℳ	Rev. C. H. Griffith.
Thurcaston (sunshine only)	-	Rev. T. A. Preston, M.A., F.R. Met. Soc.
Waterford (Brook Lodge)	-	C. Percival Bolton, J.P.
Worksop (sunshine only)	-	H. Mellish, J.P., F.R. Met. Soc.

The returns marked "ℳ" are supplied through the Royal Meteorological Society, those marked "ℒ" are through the Scottish Meteorological Society.
* Added at beginning of 1891.

The MS. of the report is now prepared on Tuesday in every week, and the printed copies are ready for sale on Thursday afternoon, but the summary on its first page is sent to the "Times," "Daily News," and several other papers on Tuesday evening.

Appendices.

Appendices, four in number, have appeared, similar to those for recent years, and a supplement in the form of a Monthly Summary.

Monthly Summary.

This Supplement to the Weekly Report gives for each calendar month the mean and principal values for the different elements, Pressure, Temperature, Rainfall, and Sunshine, and the differences between these and the averages for the corresponding months in former years. The periods covered by the averages are the same as those used in preparing the Weekly Weather Report. See page .

There are also four maps, showing the distribution of Pressure, Wind, Temperature, and Rainfall, and the movements of the principal depressions observed during the month, and some brief notes as to the chief features exhibited. These have all been issued to the end of 1890.

Issue of Forecasts.

Remarks on the actual state of the weather, and forecasts ***for not more than one day in advance***, are prepared at the Meteorological Office as under:—

On Week Days.

(1.) At 11 a.m. (from the morning reports), for the 24 hours ending at Noon on the day following the date of issue. These are intended especially for the early editions of the evening papers, for the clubs, and for exhibition at certain selected stations. See page .

(2.) At 3.30 p.m. (from the morning and afternoon reports), for the day following that of issue. This set of forecasts is not intended for publication in newspapers, but a copy is exhibited regularly at the door of the Meteorological Office.

(3.) At 8.30 p.m. (from the 8 a.m., 2 p.m., and 6 p.m. reports), for the day following that of issue. These are supplied gratis to any newspaper or news agency which may apply for them, and send for them regularly. A very large number of the most important papers and news agencies avail themselves of this advantage.

The forecasts are made for the following districts :—

0. Scotland, North.
1. Scotland, East.
2. England, N.E.
3. England, East.
4. Midland Counties.
5. England, South.
6. Scotland, West (with Isle of Man)
7. England, N.W. (with North Wales).
8. England, S.W. (with South Wales).
9. Ireland, North.
10. Ireland, South.

The remarks and forecasts are posted at the doors of the Meteorological Office, 63, Victoria Street, S.W., on week days,* for the inspection of the public. Copies, or extracts from them, are communicated under the conditions stated below, but no information which is not substantially included in them can be supplied.

A series of boards are exhibited on the front of the Office showing in large type the state of the wind, weather, and sea disturbance at six stations, situated on our S.E., S., and S.W. coasts. The stations selected are Yarmouth, Dungeness, The Needles, Scilly, Holyhead, and Valencia Island, and the observations posted up are those for 8 a.m. and 2 p.m. daily, except on Sundays,* the boards being changed at about 9.45h. a.m. and 3h. p.m. The information can be easily read from the street.

Forecasts for Subscribers.—Any person can be supplied with a copy of the 11 a.m. Forecasts, once on each week day,* on payment of a subscription of ten shillings per annum, or 2*s.* 6*d.* per official quarter, *or any part thereof, in addition to the cost of transmission ;* the charges will therefore be, by *letter* post, 9*s.*, by *book* post, 5*s.* 9*d.* per quarter.

The forecasts for any of the districts and for any of the hours mentioned on p. 9 can be forwarded by telegraph daily, on payment of 3*d.* per day for any definite period, in addition to the cost of telegraphy.

Forecasts for Clubs.—These are drawn up at 11 a.m., for all the districts, and are supplied to Clubs, for a subscription of ten shillings per annum. They are delivered free, by hand, to Clubs situated in or near Pall Mall. Special arrangements can be made for delivery at a greater distance by hand or by post.

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* Good Friday and Christmas Day are reckoned as Sundays.

FORECASTS FOR HAY AND CORN HARVESTS, OR FOR PUBLIC USE.—Special facilities are offered for the transmission of Forecasts for these purposes, a nominal fee of 2*s.* 6*d.* being charged for a quarter or any part thereof, in addition to the cost of the telegrams.

EXHIBITION OF TELEGRAPHIC FORECASTS AT LOCAL POST OFFICES.—The Post Office has sanctioned the exhibition of Forecasts at Local Post Offices, provided space is available, if the persons to whom they are addressed desire them to be so exhibited instead of being delivered.

Unless otherwise arranged, all forecasts transmitted by post are sent by book post, not as letters.

INQUIRIES as to the WEATHER.

INQUIRIES PERSONALLY OR BY MESSENGER.—Any person applying at the Meteorological Office between 11 a.m. and 8 p.m. on week days, and between 7 p.m. and 8 p.m. on Sundays, can be supplied, in writing, with the latest information in the possession of the Office and with the latest forecast issued for any specified district, on payment of one shilling for each inquiry.

INQUIRIES BY LETTER.—Application may be made by letter, enclosing thirteen pence in stamps if the reply is to be *by post*, and one shilling in stamps, in addition to the cost of the reply (consisting of ten words, exclusive of the address) if the reply is to be *by telegraph*.

INQUIRIES BY TELEGRAPH.—Any person may obtain *by telegraph* from the Meteorological Office the latest information as to the weather in any district of the United Kingdom by payment of a fee of 1*s.* in addition to the cost of a telegram and reply to any post office. The telegram containing the inquiry must be addressed as follows:

To

WEATHER,
LONDON.

The payment for the reply should be for at least ten words in addition to the address.

Application may also be made for similar information to be sent either *by telegraph* or *post* on some future specified day.

CHECKING of FORECASTS.

In order to test the accuracy of the forecasts they are compared carefully with the weather reported in the various districts on the days to which they referred, and the results of the checking for 8.30 p.m. are given in this Report (page 9).

In carrying out this comparison the portions of the forecasts which referred to wind have been carefully separated from those relating to weather. The detailed results of the comparison will be found in Appendix X., page 62.

CHECKING of STORM WARNINGS.

The testing of the warnings is still conducted in the manner indicated in earlier reports.

In order to render the information in the possession of the Office as to the weather experienced on our coasts still more complete, the Council

have, as in preceding years, made application to the various Light-house Boards, and have obtained from them the original log-books from some of the most exposed lightships and lighthouses. They would here express their cordial thanks for the co-operation so readily granted to them by these Boards.

The result of the checking for 1890 will be found on page 12.

In the course of the year improvements have been made both in the issue and checking of these storm warnings.

APPENDIX X.

REPORT ON THE COMPARISON OF THE FORECASTS ISSUED AT 8h. 30m. p.m. WITH THE WEATHER SUBSEQUENTLY EXPERIENCED, for the 12 Months, April 1889 to March 1890. The results are for the United Kingdom as a whole.

The letters used have the following signification :—

a = complete success. | **c** = partial failure.
b = partial (more than half) success. | **d** = total failure.

The checking has been conducted on the same system as that employed in previous years, *i.e.*, each forecast has been considered under the separate headings of "Wind" and "Weather," but the results of the 8.30 p.m. Forecasts only are here published.

The first column gives the per-centage of success in "Wind," the second in "Weather," and the third the average of the two.

The Summary for the whole year is given at page 9.

Months.		Per-centages.				Months.		Per-centages.			
		Wind.	Weather.	Average.	a + b.			Wind.	Weather.	Average.	a + b.
April	a	45	54	50	84	October	a	52	50	51	80
	b	35	34	34			b	27	31	29	
	c	16	7	12			c	16	13	15	
	d	4	5	4			d	5	6	5	
May	a	49	52	51	78	November	a	35	53	44	76
	b	31	24	27			b	31	33	32	
	c	12	11	12			c	27	8	18	
	d	8	13	10			d	7	6	6	
June	a	44	51	48	80	December	a	43	55	49	82
	b	36	28	32			b	37	29	33	
	c	12	12	12			c	15	7	11	
	d	8	9	8			d	5	9	7	
July	a	38	43	41	80	January	a	54	60	57	88
	b	37	42	39			b	34	27	31	
	c	15	9	12			c	8	5	6	
	d	10	6	8			d	4	8	6	
August	a	49	53	51	83	February	a	63	59	61	83
	b	29	34	32			b	19	25	22	
	c	15	9	12			c	13	5	9	
	d	7	4	5			d	5	11	8	
September	a	47	48	48	84	March	a	35	69	52	83
	b	35	38	36			b	42	19	32	
	c	15	9	12			c	19	8	13	
	d	3	5	4			d	4	4	4	

APPENDIX XI.

Telegraphic Weather Intelligence.

The following stations are supplied with telegraphic information of storms, free of expense, and signal "cones" have been furnished to most of them, all further expenses attendant on the maintenance and repair of the apparatus being borne locally. The stations are situated, 94 in England and Wales, 46 in Scotland, 20 in Ireland, 3 in the Isle of Man, and 3 in the Channel Islands.

NORTH.	WEST.	SOUTH.	EAST.
Scotland, N.E.	Ireland, S.W.	England, S.W.	England, E.
Lerwick.	New Ross.	St. Just.	Harwich.
Scalloway.	Dunmore East.	St. Sennen.	Ipswich.
Dunrossness.	Dungarvan.	Penzance.	Southwold.
Stromness.	Youghal.	Scilly.	Yarmouth.
Kirkwall.	Queenstown.	The Lizard.	Cromer.
Holborn Head.	Passage.	Falmouth.	Sheringham.
Dunnet Head.	Cork.	Pendennis.	Lynn.
Wick.	Kinsale.	Mevagissey.	Sutton Bridge.
Avoch.	Do. (Old Head)	Plymouth.	
Inverness.	Brow Head.	Devonport.	
Nairn.	Tralee.	Prawle Point.	
Burghead.	Limerick.	Teignmouth.	
Lossiemouth.	Galway.	Exmouth.	
Buckie.			
Port Knockie.	Ireland, N.W.		
Cullen.	Malin Head.		
Portsoy.	Portrush.		
Banff.	Port Ballintrae.	England, S.	
Fraserburgh.		Guernsey.	England, N.E.
Peterhead.	Irish Sea.	St. Helier's (Jersey).	Boston.
Aberdeen.	Belfast.	Gorey (Jersey).	Cleethorpes.
	Donaghadee.	Weymouth.	Grimsby.
	Howth.	Poole.	Goole.
	Kingstown.	Cowes.	Hull.
Scotland, E.	Ramsey (I. of M.).	Ryde.	Bridlington Quay.
Stonehaven.	Douglas "	St. Catherine's Point.	Filey.
Montrose.	Castletown "	Portsmouth.	Whitby.
Broughty Ferry.	Silloth.	Littlehampton.	Redcar.
Dundee.	Maryport.	Brighton.	Middlesborough.
St. Andrews.	Workington.	Newhaven.	West Hartlepool.
Anstruther.	Whitehaven.		Sunderland.
Pittenweem.	Barrow.		South Shields.
Burntisland.	Morecambe.		Tynemouth.
Grangemouth.	Fleetwood.		Berwick - on - Tweed.
Bo'ness.	Blackpool.		
Granton.	Lytham.	England, S.E.	
Newhaven.	Southport.	Hastings.	
Leith.	Liverpool.	Rye.	
Fisherrow.	Runcorn.	Sandgate.	
Dunbar.	Connah's Quay.	Folkestone.	
Cockburnspath.	Penmaenmawr.	Dover.	
St. Abb's Head.	Port Penrhyn.	Margate.	
Eyemouth.	Port Dinorwic.	Faversham.	
	Carnarvon.	Sheerness.	
	Holyhead.	Chatham.	
	St. George's Channel.		
	Aberystwith.		
	Milford.		

[*continued.*

NORTH.	WEST.	SOUTH.	EAST.
Scotland, N.W.	Bristol Channel.		
Port of Ness (Island of Lewis).	Pembrey.		
	Llanelly.		
	Swansea.		
	Briton Ferry.		
	Porthcawl.		
	Penarth.		
	Cardiff.		
Scotland, W.	Do. Barry Dock.		
	Newport.		
Glasgow.	Weston-super-Mare.		
Greenock.	Burnham.		
Rothesay.	Bridgewater.		
Campbelton.	Ilfracombe.		
Girvan.	Barnstaple.		
Ballantrae.	Appledore.		
	Boscastle.		
	Port Isaac.		
	Newquay.		
	Hayle.		
	St. Ives.		

APPENDIX XII.

Fishery Barometers.

List of Places supplied with Fishery Barometers.

Shetland Isles.—Balta Sound, Uya Sound, Nesting, Lerwick, Sandsair, Scalloway, Symbister.

Orkney Isles.—Westray, Burra, Kirkwall.

Scotland, east coast.—Freswick, Auchengill, Keiss, Staxigoe, Wick, Sarclet, Lybster, Dunbeath, Portmahomack, Cromarty, Avoch, Nairn, Burghead, Portessie, Port Knockie, Portsoy, Whitehills, Gardenstown, Rosehearty, Pitullie, Fraserburgh, Inverallochy, Pointlaw, Findon, Portlethen, Skateraw, Stonehaven, Arbroath, Broughty Ferry, St. Andrews, Crail, Cellardyke, St. Monance, Burntisland, Newhaven.

England, east coast.—Berwick, North Shields, South Shields, Sunderland, West Hartlepool, Staithes, Scarborough, Filey, Flamborough, Bridlington Quay, Withernsea, Hull, Lynn (2), Wells, Gorleston, Harwich, Brightlingsea, West Mersea, Margate, Deal, Kingsdown, Dover.

England, south coast.—Bognor, Ryde, Bembridge, Brixton, Atherfield, Ventnor (2), Gorey (Jersey), Haslar Hospital, Poole, Weymouth, Portland, Budleigh Salterton, Exmouth, Cawsand, Mevagissey, Gorranhaven, Devoran, Portscath, Penryn, Durgan, Porthallow, Falmouth, Coverack, Newlyn, Mousehole.

England, south-west coast.—St. Ives, Hayle, Port Isaac, Boscastle, Burnham, Highbridge, Weston-super-Mare.

Wales.—Briton Ferry, Swansea, Angle, Milford, Nevin, Carnarvon.

England, north-west coast.—Fleetwood, Morecambe, Maryport.

Isle of Man.—Douglas, Port St. Mary, Peel (2).

Scotland, south-west coast.—Port Patrick, Stranraer.

Ireland, east coast.—Cushendall, Belfast, Bangor, Groomsport, Donaghadee, Ardglass, Warren Point, Carlingford, Greenore, Dundalk, Malahide, Howth, Kingstown (2), Bray, Wicklow.

Ireland, south coast.—Dunmore East, Dungarvan, Crosshaven, Kinsale, Union Hall, Castletownsend, Baltimore, Schull, Crookhaven.

Ireland, west coast.—Valencia, Dingle, Tralee, Tarbert, Kilcredane, Kilronan, Spiddal, Elly Bay, Ballyglass, Ballycastle (Co. Mayo), Donegal, Tribane, Killybegs, Teelin, Portnoo, Burton Port, Kincaslagh, Bunbeg.

Ireland, north coast.—Dunfanaghy, Rathmullen, Buncrana, Moville, Greencastle, Portstewart, Portrush, Ballycastle (Co. Antrim).

Scotland, west coast.—Tarbert (Loch Fyne), Campbeltown, Carradale, Portree (Isle of Skye), Plockton, East Mey, Stroma.

Hebrides.—Stornoway, Portnaguiran, Obb, Valtos, Carloway, Ness.

Summary of Stations supplied with Instruments.

England and Wales - - - - -	65
Scotland and Isle of Man - - - -	64
Ireland - - - - - -	51
	180

APPENDIX XIII.

LIST of STATIONS from which CONTINUOUS RECORDS of BRIGHT SUNSHINE have been received.

Station.	Observer.
Aberdeen Observatory	Prof. C. Niven, M.A., F.R.S.
Armagh	J. L. E. Dreyer, Ph.D., F.R.A.S.
Blackpool	J. Wolstenholme.
Cambridge	H. Todd.
Churchstoke	P. Wright, F.C.S., F.R. Met. Soc.
Cirencester	Prof. Ohm, B.A., F.R. Met. Soc.
Cronkbourne, Isle of Man	A. W. Moore, M.A., J.P.
Cullompton	Thos. Turner, J.P., F.R. Met. Soc.
Dublin, Mountjoy Observatory	Major Kirkwood, R.E.
Durham	H. J. Carpenter.
Eastbourne	R. Sheward, F.R. Met. Soc.
Falmouth Observatory	E. Kitto, F.R. Met. Soc.; for the R. Cornwall Polytechnic Soc.
Fort Augustus	(The late) Rev. E. G. Cody, O.S.B., and Rev. A. Weld-Blundell, O.S.B.
Fort William	R. T. Omond, F.R.S.E.; for the Scottish Meteorological Society.
Geldeston, Beccles	E. T. Dowson, F.R. Met. Soc.
Glasgow	Prof. R. Grant, M.A., LL.D., F.R.S.
Harpenden	T. Wilson, F.R. Met. Soc.
Hastings	H. Colborne, M.R.C.S.
Hillington	Rev. H. E. B. Ffolkes, M.A., F.R. Met. Soc.
Jersey (St. Helier's)	Capt. Bichard, Harbour Master.
Kew Observatory	G. M. Whipple, B.Sc., F.R.A.S.; for the Kew Committee.
Leicester (Thurcaston)	Rev. T. A. Preston, M.A., F.R. Met. Soc.
Llandudno	J. Nicol, M.D., J.P., F.R. Met. Soc.
London, Bunhill Row	Messrs. de la Rue.
„ Westminster	The Staff, Meteorological Office.
Marchmont	P. Loney; for Sir Hugh P. Campbell, Bt.
Markree Castle	A. Marth, F.R.A.S.; for Col. E. H. Cooper, F.R.A.S.
Newton Reigny (Penrith)	T. G. Benn, F.R. Met. Soc.
Oswaldkirk, Yorkshire	R. Thompson.
Oxford	E. J. Stone, F.R.S.
Parsonstown	O. Boeddicker, Ph.D.; for the Earl of Rosse, K.P., F.R.S.
Plymouth	J. Merrifield, LL.D., F.R.A.S.
St. Ann's Head	S. Blake, Principal Lightkeeper.
Southampton	Sir C. Wilson, Col. R.E., K.C.B., F.R.S.
Stenness (Orkney)	M. Spence.
Stonyhurst	Rev. W. Sidgreaves, S.J.
Stornoway	John Forbes.
Sutton Coldfield	C. F. Marston, C.E.
Valencia	J. E. Cullum, F.R. Met. Soc.
Westgate-on-Sea	J. Norman Lockyer, F.R.S.
Worksop	H. Mellish, F.R. Met. Soc.
York	J. E. Clarke, B.A., B.Sc.
Georgetown, British Guiana	G. S. Jenman.

In addition, the number of hours sunshine recorded each day is reported from the following Stations :—

Arley Cottage (Co. Cavan)	Major Somerset H. Maxwell.
Edinburgh	R. C. Mossman, F.R. Met. Soc.
Braemar	James Aitken, J.P.
Stowell	Rev. H. J. Poole, F.R. Met. Soc.
Torquay	Alfred Chandler.

APPENDIX XIV.

METHODS FOLLOWED IN DEALING WITH METEOROLOGICAL RETURNS FROM LAND STATIONS IN THE BRITISH ISLES.

These stations are of five classes, as stated on page 15.

I.—*Observatories continuously observing all the Meteorological Elements.*

Returns from observatories.

Hourly measurements of the curves obtained from the self-recording instruments at the observatories of the Office are made by the observers at each station, on printed forms supplied for the purpose, which, together with the curves, are forwarded to the Office weekly. They comprise measurements of the barograms, of the dry bulb and wet-bulb thermograms, of the anemograms, and of the rain-gauge curves.

Examination of returns.

The measurements are subjected to a careful examination in order to ensure as far as possible their accuracy, and the revised regulations which have been adopted to secure this end will be found in the Report of the Office for 1890. They comprise rules for the guidance of observers, as well as of the assistants charged with the examination of the work at the Office. Attention need be called here to only two of these rules, viz., (*a*) the use of subsidiary sheets on which are entered the results of a second set of measurements of the curves made after, and quite independently of, the first set, and with a different form of scale, the two sets of measurements being afterwards compared together, and any differences found inquired into and set right; and (*b*) the re-measurements of the curve made by the assistants at the Meteorological Office, and which always amount to 40, and in doubtful cases to many more, per month, for each element.

Results of examination and report to Council.

The attention of the observers is always drawn to such errors as may be detected, and to any failures in the continuity of the curves arising from failure of the light, stoppage of the clock, defective photography, faulty action of the wet bulb thermometer, &c.; a report containing the results of the examination of each Observatory being also submitted to the Council periodically. The curves and tabulations are eventually bound and stored in the Office.

General supervision of observatory work.

In connexion with this work should be mentioned the general watch which has to be kept over the working of the observatories and of the instruments, not only to secure uniformity amongst them and observance of rules, but also to guard against small changes which are liable to occur at certain times, especially with the thermographs, and which may affect the scale-values of the instrument or the datum lines used for the tabulation of the curves. About twice a year this work calls for special examination, entailing some considerable time and occasionally the engraving of new scales for measuring the curves.

METHOD OF DEALING WITH THE NUMERICAL RESULTS FROM THE SELF-RECORDING OBSERVATORIES.

Interpolations.

In dealing with the tabulations the first step is to go over the sheets and fill up by interpolation, wherever possible, any gaps or breaks in the continuity of the record.

The records having been made as complete as possible, are then used for the calculation of daily and hourly mean values, for periods of five days, calendar months, and for the year; which, together with other data obtained from the same source, are published under the title of "Hourly Means of the Readings obtained from the Self-recording "Instruments at the Four Observatories under the Meteorological

" Council." The volume for 1887 has been issued during the year, and considerable progress has been made with the calculations for the year 1888.

Tables for the Quarterly Weather Reports. Gale tables.

The gale tables printed in the text of the Quarterly Weather Report, which show the extent, duration, and degree of severity of all the stronger gales, are prepared from the tabulations of the anemograms received from the self-recording observatories, together with those received from the extra anemographic stations.

II.—*Anemographic Stations at which the Wind is recorded continuously.*

The anemograms received from the stations enumerated on page 70 are regularly examined and tabulated in the Office, and the sheets bound up in volumes. Besides special inquiries on legal and other points that from time to time arise, and in which these documents are of high importance, the tabulations are always employed in the preparation of the summary of weather and gale tables for the Quarterly Weather Report. They are also regularly used in the checking of the Storm Warnings issued by the Office.

III.—*Land Stations of the Second Order.*

Origin and progress of system.

Ever since the year 1866 returns of more or less completeness have been received from land stations in the United Kingdom. In that year there was only one station, but by 1871 the number had increased to 15, and five years later to 49, including 14 stations belonging to the Royal Meteorological Society, copies of the returns from which were sent to the Office under a special arrangement with the Society.

At the end of the present year the total number of stations was 103, including 17 belonging to the Royal Meteorological Society and 19 belonging to the Scottish Meteorological Society. This is an increase of 6 stations as compared with the previous year.

It must, however, be observed that while this number is exclusive of the self-recording observatories and of the anemographic stations, it includes several others from which only very scanty information is received.

The stations are distributed as follows: 45 in England, 5 in Wales, 28 in Scotland, and 25 in Ireland.

The methods followed with regard to the examination and publishing of these returns have been fully detailed in previous reports, and need not now be repeated. The changes introduced into the volume for 1886 have been continued in that for 1887. These refer to the barometer readings, which are now given at station-level instead of being reduced to the mean sea-level; and to the humidity, where the depression of wet-bulb is shown, the international forms A and B being modified accordingly.

The volume for 1887 contains returns from 66 stations.

Arrangements have been made under which it is hoped that the arrears of this publication will be rapidly reduced.

Reports from 11 of the Irish stations are regularly supplied to the Registrar-General for Ireland for his Weekly and Quarterly Returns.

New stations.

When an application for the adoption of a new station is received, a schedule is forwarded to the observer containing a series of questions as to the outfit of the station, the exposure of the instruments, and the influence likely to be exerted on their indications by surrounding objects, such as houses and trees. Only mercurial barometers are accepted, and only such as have been duly verified. All thermometers must have been

tested at Kew. A plan of the station, showing the positions of the instruments with regard to neighbouring objects, is also required.

On the return of this schedule the answers are considered, and, where necessary, alterations are advised.

If, however, the existing arrangements are satisfactory, tables for reducing the barometer readings to 32° Fahrenheit at mean sea level are prepared and duplicates sent to the observer, together with a set of Hygrometrical Tables, and a copy of "Instructions in the Use of Meteorological Instruments."

The first returns are compared and examined with special care, and a report of the result of the examination is forwarded to the observer, with instructions how best to improve and complete the returns.

There are still many parts of the British Islands very poorly represented by the existing stations, and any information for these districts would be valuable.

Sunshine records.

The daily records of sunshine which are now received from 42 Stations in the British Islands are examined generally to guard against accidental changes in the adjustment of the instruments. Notes explaining any omission or accidental defect are added to the cards if required, and after their receipt has been acknowledged, they are duly stamped and dated and then stored in the Office.

Weekly totals.

A tabulation of these curves is published as part of the Weekly Weather Report, mentioned in Appendix VIII., and for those stations which are also Stations of the Second Order the monthly totals of bright sunshine in hours, together with the per-centages of its possible duration, published as Part IV. of "Returns from Stations of the Second Order." A table showing the daily amount of sunshine at Bunhill Row, one of the London stations, is also prepared quarterly for the Royal Meteorological Society.

Inspection.

The Stations of the Second Order are regularly inspected, the attention of the inspector being directed by the Office to any special point which may require investigation.

IV.—*Telegraphic Reporting Stations.*

Full particulars relating to these stations, the information received from them, and the method of dealing with that information, will be found in Appendix VII. to the Report for the year 1888–9. A paragraph in that Appendix (p. 60) explains the use that is made of the monthly schedules sent in by the observers.

V.—*Extra Stations.*

No returns from Stations of the Fifth Class are published by the Office, but some of them are regularly used in the checking of the Storm Warnings, and all are available for any special investigation that may be taken up.

The rainfall values at these stations are, however, copied and supplied to Mr. Symons, F.R.S., for publication in "British Rainfall."

APPENDIX XV.

List of Documents relating to the Land Meteorology of the British Islands, received during the Year ending March 31st, 1891.

Stations.	Observers.	Nature of Information received.	Notes.
Class I. †Valencia	J. E. Cullum, F.R. Met. Soc.	Continuous records of pressure, temperature, wind, sunshine, and rain, with eye observations of the clouds and notes on the weather.	
†Aberdeen	Prof. C. Niven, M.A., F.R.S.		
†Falmouth	E. Kitto, F.R. Met. Soc.		
†Kew	G. M. Whipple, B.Sc., F.R.A.S., F.R. Met. Soc.		
†Glasgow	Prof. R. Grant, M.A., LL.D., F.R.S.	Continuous records of pressure, temperature, wind, sunshine, and rain.	
†Stonyhurst	Rev. W. Sidgreaves, S.J.		
Class II. †Armagh	J. L. E. Dreyer, Ph.D., F.R.A.S.	Continuous record of wind, rainfall, and sunshine.	
Alnwick Castle	Lt.-Col. F. Holland, for the Duke of Northumberland, K.G.	Continuous record of wind (direction and velocity).	
†Dublin (Phœnix Park)	Major Kirkwood, R.E.	" "	
†Fleetwood	M. S. Gaulter, C.E.	" "	
†Holyhead	Hugh Williams, C.E.	" "	
†North Shields	Capt. W. Harrison	" "	
†Scilly	A. Hicks	" "	
†Swanbister (Orkney)	W. Irvine Fortescue	" "	Till August 25th.
Stenness (Orkney)	M. Spence	" "	From August 27th.
†Yarmouth	G. T. Watson	" "	
†Kilkenny Castle	The Marquis of Ormonde, K.P.	Continuous record of pressure.	
London	The Athenæum Club	" "	
†Waterford	The Harbour Authorities	" "	
Class III. †Armagh	J. L. E. Dreyer, Ph.D., F.R.A.S.	Regular observations at 9 a.m. and 9 p.m. of pressure, temperature (dry-bulb and wet-bulb), wind, cloud and weather, with the daily maxima and minima of temperature, the daily rainfall, and general remarks on the weather.	
Aysgarth	Rev. Fenwick W. Stow, M.A., F.R. Met. Soc.		
†Braemar	James Aitken, J.P.		
†Brookeborough	W. Ferguson, for Sir Victor Brooke, Bt., F.L.S.		
†Carmarthen	G. J. Hearder, M.D.		
†Clober (Milngavie)	A. M. Bertram	- - - - - -	From August 1890.

List of Documents—*continued.*

Stations.	Observers.	Nature of Information received.	Notes.
†Cronkbourne, I. of Man	A. W. Moore, M.A., J.P.	Regular observations at 9 a.m. and 9 p.m. of pressure, temperature (dry-bulb and wet-bulb), wind, cloud and weather, with the daily maxima and minima of temperature, the daily rainfall, and general remarks on the weather.	
†Dartmoor	F. W. S. Stone, M.B.		
†Douglas, Isle of Man	Thos. Keig		
†Dublin (City)	J. W. Moore, M.D., F.R. Met. Soc.		
†Dublin (Phœnix Park)	Corporal Stone for Major Kirkwood, R.E.		
†Dublin (Glasnevin)	F. W. Moore, M.R.I.A.		
†Dundee	W. Ross McKelvie		
†Dunrobin Castle	D. Melville, for the Duke of Sutherland, K.G.		
†Durham	H. J. Carpenter		
†Eastbourne	R Sheward, F.R. Met. Soc.		
†Edgeworthstown	J. M. Wilson, M.A., J.P.		
†Edinburgh	R. C. Mossman, F.R. Met. Soc.		From June 1890.
†Epsom (Royal Med. College).	J. S. Jackson and E. C. Montgomery		
Geldeston (Beccles)	E. T. Dowson, F.R. Met. Soc.		
†Glasgow	Prof. R. Grant, M.A., LL.D., F.R.S.		
Hillington, Norfolk	Rev. H. E. B. Ffolkes, M.A., F.R. Met. Soc.		
†Ladylaw, Hawick	W. R. Wilson		
Langton (Dorset)	H. Stilwell		From January 1891.
†Laudale (Argyleshire)	A. Fletcher, for T. H. G. Newton, M.A., J.P.		
Liverpool	J. Hartnup, F.R.A.S., F.R. Met. Soc.		
†Londonderry	J. Conroy, F.R. Met. Soc.		
Margate	J. Stokes, F.R. Met. Soc.		
†Markree Castle, Sligo	A. Marth, F.R.A.S., for Col. Cooper, F.R.A.S.		
Mount Nugent (Arley Cottage).	Major Somerset H. Maxwell, F.R.A.S.		From January 1891.
†Newton Reigny (Penrith).	T. G. Benn, F.R. Met. Soc.		
Parkstone	R. H. Barnes, B.A., F.L.S., F.R. Met. Soc.		From May 1891.
†Parsonstown	O. Boeddicker, Ph.D., for the Earl of Rosse, K.P., F.R.S.		
†Prestwich (Manchester)	T. R. H. Clunn, M.D., F.R. Met. Soc.		
†St. David's, Pembroke	W. P. Propert, LL.D., F.G.S., F.R. Met. Soc.		

List of Documents—*continued.*

Stations.	Observers.	Nature of Information received.	Notes.
Scarborough	W. Robinson	Regular observations at 9 a.m. and 9 p.m. of pressure, temperature (dry-bulb and wet-bulb), wind, cloud and weather, with the daily maxima and minima of temperature, the daily rainfall, and general remarks on the weather.	
†Seaham	G. H. Aird		
Southampton	J. T. Cook, for Dir. Gen. of Ordnance Survey.		
†Stokesay	Miss M. A. Digges La Touche		
†Stonyhurst	Rev. W. Sidgreaves, S.J.		
†Sutton Coldfield	C. F. Marston, C.E.		
†Swanbister	W. Irvine Fortescue		Now Stenness.
Tenby	J. E. Gower		From February 1891.
Uppingham	Rev. G. H. Mullins, M.A., F.R. Met. Soc.		
†Wolfelee (Roxburghshire).	M. W. Cockburn, for Lady Elliott		
†York	J. Wright, for Yorkshire Phil. Soc.		
Class IIIa. †Babbacombe, Devon.	E. E. Glyde, F.R. Met. Soc.	Monthly means and summaries on Form B. of observations taken at 9 a.m. and 9 p.m. each day as above.	
Bennington, Herts	Rev. J. Dunne Parker, LL.D., F.R. Met. Soc.		
Berkhamsted	E. Mawley, F.R.H.S., F.R. Met. Soc.		
†Buxton	E. J. Sykes, M.B., F.R.A.S., F.R. Met. Soc.		
†Callton Mor	J. Russell, for J. Malcolm of Poltalloch, M.P.		
Cargen (Dumfries)	P. Dudgeon, F.R.S.E., and Alex. Peacock		
Cheadle	J. C. Philips		
†Cheltenham	R. Tyrer, B.A., F.R. Met. Soc.		
†Churchstoke	P. Wright, F.C.S., F.R. Met. Soc.		
Cramlington	W. Bonallo, F.R. Met. Soc.		
†Fort Augustus	The late Rev. E. G. Cody and Rev. A. Weld Blundell, O.S.B.		
†Fort William	C. Livingston, for Directors of Ben Nevis Observatory.		
†Glencarron	D. D. Munro, for Lord McLaren		
†Glenlee (Kirkcudbrightshire).	W. Melville, for George Maxwell		
†Gordon Castle	J. Webster, for the Duke of Richmond, K.G.		

LIST OF DOCUMENTS—*continued.*

Stations.	Observers.	Nature of Information received.	Notes.
☔†Killarney - -	The Ven. Archdeacon G. R. Wynne, M.A., F.R. Met. Soc.	Monthly means and summaries on Form B. of observations taken at 9 a.m. and 9 p.m. each day as above.	
☀†Lairg - -	J. Young, for The Duke of Sutherland, K.G. -		
☀†Lednathie (Forfarshire).	W. Morrison, for Stormonth Darling, Q.C. -		
☀†Lissan (Co. Tyrone) -	Sir Nathaniel Staples, Bart. - - -		
☔†Llandudno - -	J. Nicol, M.D., F.R. Met. Soc. - -		
☀†Marchmont - -	Peter Loney, for Sir Hugh P. Campbell, Bt. -		
☀†Ochtertyre - -	G. Croucher, for Sir Patrick Keith Murray, Bt.		
☀†Pinmore - -	Peter Donald, for Capt. Hamilton - -		
☀†Rosewell - -	R. W. D. Cameron, M.D. - - -		
☀†Rothesay (Isle of Bute)	James Kay - - - - -		
☔†Rousdon - -	C. E. Peek, M.A., F.R.A.S., F.R. Met. Soc. -		
☔ Wakefield - -	H. Clarke, L.R.C.P., F.S.S., F.R. Met. Soc. -		
CLASS IV. The Telegraphic Stations, see List on page 36.			
CLASS V. Baltimore -	J. Halsey - - - - -	Pressure, temperature, wind, and weather, once daily.	
Bolton - -	W. W. Midgley, F.R. Met. Soc. - -	Full monthly summary.	
Bray (Co. Wicklow) -	Coast Guard - - - - -	Pressure and temperature four times daily, with wind and weather twice daily.	
Castletownsend -	Coast Guard - - - - -	Pressure and temperature four times daily, and wind twice daily.	
Chatham (School of Military Engineering).	L. M. S. Hall, for Instructor in Surveying -	Full return for 9 a.m.	
Cooper's Hill (Egham)	Prof. H. McLeod, F.R.S. - - -	Full return for 9 a.m. and 3 p.m.	
Crookhaven - -	Coast Guard - - - - -	Pressure and temperature four times daily, and wind twice daily.	
Crosshaven - -	J. W. Bridle - - - - -	Pressure, temperature, and wind, twice daily.	

LIST OF DOCUMENTS—*continued.*

Stations.	Observers.	Nature of Information received.	Notes.
Cuckfield	John Howe	Daily rainfall.	
Ennis	J. Hill, M.I.C.E., F.R. Met. Soc.	Daily rainfall.	
Galway	Coast Guard	Pressure and temperature four times daily, with wind.	
Gorleston	R. J. C. Day	Pressure and wind twice daily.	
Harpenden	T. Wilson, F.R. Met. Soc.	Pressure, temperature, and wind, twice daily, with rainfall.	
Haslar Hospital	G. Coppen	Pressure and temperature four times daily.	July to December 1889.
Knightstown (Valencia).	Coast Guard	Pressure, wind, and weather once daily.	
North Arran	Coast Guard	Pressure, temperature of air and sea four times daily, with wind and weather at noon.	
Rosehearty	Coast Guard	Pressure once daily.	
†Rugby	W. N. Wilson, M.A., and H. P. Highton, B.A.	Full set of 9 a.m. observations with 9 p.m. temperatures.	
†St. Leonards	H. Colborne, M.R.C.S.	Full set of 9 a.m. observations.	
Schull	Coast Guard	Pressure, temperature, and wind twice daily.	
Sheffield (Weston Park)	Elijah Howarth, F.R.A.S.	Full return for 9 a.m. and 6 p.m.	
Stamford (Ketton Hall)	Fred. Coventry	Pressure, temperature (max., min., min. on grass), rainfall, and wind once daily.	
Stranraer	P. Doran	Pressure, wind, and weather once daily.	
Sudbury	W. Bayley Ransom	Pressure, temperature (dry-bulb, max., min.), wind, cloud, and rainfall, once daily, with general remarks.	
Symbister, Shetland	J. S. Nicolson	Pressure and temperature twice daily.	
Tarbert, Harris	Donald Bethune	Pressure and wind twice daily.	
Totland Bay	John Dover, B.A., F.R. Met. Soc.	Full return for 9 a.m.	
Union Hall (Glandore)	Coast Guard	Pressure, temperature, and wind, twice daily.	

NOTE.—The Stations marked "℞" belong to the Royal Meteorological Society; those marked "♆" belong to the Scottish Meteorological Society; those marked thus † have been inspected during the year.

APPENDIX XVI.

Accessions to the Library during the Year ending 31st March 1891.

* **Abich, [W. H.]**—Meteorologische Beobachtungen in Transkaukasien. Lu le 12 avril 1850. la. 4°. (*Bull. Cl. Phys. Math. Acad. Imp. Sc. St. Petersb.*, ix.)]

Adelaide Observatory.—Meteorological observations made at the Adelaide Observatory, and other places in South Australia and the Northern Territory, under the direction of **C. Todd.** 1883, 1888. 2 vols. sm. f°. Adelaide, 1889–90. [1887, 1890.]

|| **Agamennone, G.**—Il terremoto a Roma del 23 Febbraio, 1890 ed il sismometrografo Brassart. sm. f°. Roma, 1890. (*Ann. Uff. Centr. Meteor. e Geodinam.*, x., 1888, *Parte* iv.)

|| ——— Sopra la correlazione dei terremoti con le perturbazioni magnetiche. la. 8°. Roma, 1890. (*Rend. R. Accad. Lincei*, vi., 1890, *p.* 21.)

|| **Aguilar Santillán, R.**—Apuntes relativos á algunos observatorios é institutos meteorológicos de Europa. la. 8°. Mexico, 1889. (*Mem. Soc. Cient. Antonio Alzate*, iii., 1889, *No.* 1.)

——— Bibliografía meteorológica mexicana que comprende las publicaciones de meteorologia, fisica del globo y climatologia hechas hasta fines de 1889. la. 8°. México, 1890.

[Algiers, Service Météorologique du Gouvernement Général de l'Algérie.]—Bulletin météorologique de l'Algérie. 1890, Jan. 1—Dec. 31. oblong sm. f°. Sheets.

[Allahabad, Meteorological Office.]—Brief sketch of the meteorology of the North-Western Provinces and Oudh, and adjacent parts of Rájputana and the Panjáb. 1889. sm. f°. s.l.e.a.

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|| **Wild, H.**—Inductions-Inclinatorium neuer Construction und Bestimmung der absoluten Inclination mit demselben in Pawlowsk. Lu le 20 Nov. 1890. la. 4°. St. Pétersbourg, 1891. (*Mém. Acad. Imp. Sc. St. Pétersb.*, vii^e *sér.*, xxxviii., *No.* 3.)

|| ——— Neuer Anemograph und Anemoscop. sm. f°. St. Pétersbourg, 1890. (*Mél. phys. chim.*, xiii., *p.* 139.)

|| ——— Ombrograph und Atmograph. sm. f°. (St. Petersburg), 1890. (*Repert. Meteor.*, xiii., *No.* 8.)

|| ——— Über die Benutzung des electrischen Glühlichts für photographisch-selbstregistrirende Apparate. sm. f°. St. Pétersbourg, 1891. (*Mélanges phys. chim.*, xiii., *livr.* 2, *p.* 173.)

Wiltshire Rainfall.—1887–89. 3 vols. oblong 8°. Marlborough, 1888–90.

Winterhalter, A. G.—The international astrophotographic Congress and a visit to certain European observatories and other Institutions: Report to the Superintendent. Washington Observations for 1885. Appendix I. la. 4°. Washington, 1889.

Wolf, R.—Mémoire sur la période commune à la fréquence des taches solaires et à la variation de la déclinaison magnétique. 4°. (*Mem. R. Astr. Soc.*, xliii., 1875–77, *p.* 199.)

|| **Wollny, E.**—Forstlich-meteorologische Beobachtungen. Zweite Mittheil. 8°. (*Forschungen auf dem Geb. Agrik.-phys., Heidelberg*, xiii., *Heft* 1 *u.* 2, *p.* 134.)

|| ——— Untersuchungen über das Verhalten der atmosphärischen Niederschläge zur Pflanze und zum Boden. 8°. (*Forschungen auf dem Geb. Agrik.-phys., Heidelberg*, xiii., *Heft* 3 *u.* 4.)

Wragge, C. L.—Table of rainfall in Queensland, 1874 to 1887. sm. 8°. (*Pugh's Almanac and Queensland Directory*, 1889.)

Yale Observatory.—Report for the year 1889–90, presented by the Board of Managers of the Observatory of Yale University to the President and Fellows. la. 8°. s.l.e.a.

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For the second half of the year the title is in French.

——— Tabellarische Zusammenstellung der Haupt.-Ergebnisse für das Jahr 1886. f°. Bern, s.a.

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——— **Schweizerische meteorologische Central-Anstalt.** — Annalen. 1887, 1888. Der "Schweizerischen meteorologischen Beobachtungen." xxiv., xxv. Jahrg. 2 vols. 4°. Zürich, s.a.

——— ——— Wetterbericht, 1890, Jan. 1—Dec. 31. sm. f°. Sheets.

APPENDIX XVII.

Meteorological Office : Account of Receipts and Payments for the year ending 31st March 1891.

Receipts.	£ s. d.	£ s. d.	Payments.	£ s. d.	£ s. d.
Balance from year 1889–90 -		3,416 6 8	Administration:		
Parliamentary Vote - -		15,300 0 0	Payment of Council -	988 15 0	
Repayment of expenses charged under—			Secretary - -	800 0 0	
(1.) Incidental expenses -	15 2 7		Salaries and wages -	789 14 0	
(2.) Expenses incidental to International Meteorological Congress -	12 12 0		Rent, fuel, and lighting	713 6 10	
(3.) Special researches -	2 3 11		Incidental and contingent expenses:—		
(4.) Observatories -	3 10 6		Attendance, cleaning, &c. - -	372 15 2	
		33 9 0	Furniture and fittings	438 0 10	
Supply of Information:			Expenses incidental to International Meteorological Congress - -	69 13 8	
D.W. Charts and Forecasts -	258 14 1		Pensions - -	186 16 4	
6 p.m. Charts -	25 0 0				4,359 1 10
Information for Press Agencies, &c. -	130 11 2		Special Researches	- - -	997 7 2
Telegrams -	288 6 2		Land Meteorology:		
		702 11 5	Observatories and stations - -	2,308 18 0	
Sale of Instruments, &c.:			Salaries: —Discussion and reduction of observations - -	1,246 18 0	
Royal Navy (A)	31 12 0				3,555 16 0
Mercantile Marine account (B)	58 0 7		Weather Information and Forecasts:		
		89 12 7	Telegraphic reports and storm warnings	2,565 2 8	
Commissions executed for Colonial and Foreign Institutions, &c. (C) - -		672 17 10	Salaries: — Preparation and issue of reports and forecasts -	1,810 10 8	
Commission charged on work done for Colonies, &c. -		37 8 5			4,375 13 4
			Inspections:		
			Salaries and travelling expenses - -	- - -	706 8 9
			Ocean Meteorology:		
			Salaries:—Discussion and reduction of observations - -	1,608 0 0	
			Expenses incidental to the supply of instruments:—		
			Proportion for care and issue of instruments - -	200 0 0	
			Royal Navy - -	566 7 6	
			Mercantile Marine -	190 6 8	
			Distant island and coast stations -	4 16 8	
					2,569 10 10
			Commissions executed for Colonial and Foreign Institutions, &c. - -	- - -	587 6 10
			Balance:		
			Cash at Bank -	3,024 12 4	
			„ at Office -	76 8 10	
					3,101 1 2
	£	20,252 5 11		£	20,252 5 11

In the year 1890–91 the sum of 1,515*l.* 10*s.* 8*d.* was paid to the Post Office on account of inland and foreign telegrams, allowances to clerks, and rental of private wires.

APPENDIX XVIII.

LIST OF PUBLICATIONS, &c. issued under the Authority of the Meteorological Council.

OFFICIAL.

No. 1. Report for 1867. Presented to Parliament. 1*s.*
2. Instructions for Meteorological Telegraphy. New Edition 1891, prepared for the use of observers exclusively.
3. Fishery Barometer Manual. (New edition, 1887.) 6*d.*
4. Charts of Surface Temperature, South Atlantic Ocean. 2*s.* 6*d.*
5. Report for 1868. Presented to Parliament. 5*d.*
6. Report for 1869. Presented to Parliament. 10*d.*
7. Quarterly Weather Report for 1869.—Parts I. to IV. 5*s.* each.
8. Barometer Manual. (Out of print, see Nos. 3, 24, 40, 60, and 61.)
9. Quarterly Weather Report for 1870.—Parts I. to IV. 5*s.* each.
10. Report for 1870. Presented to Parliament. 10*d.*
*11. Contributions to our Knowledge of the Meteorology of Cape Horn and the West Coast of South America. 2*s.* 6*d.*
*12. Currents and Surface Temperature of the North Atlantic Ocean, from the Equator to Lat. 40° N., for each month of the year, with a General Current Chart. 2*s.* 6*d.*
13. A Discussion of the Meteorology of the Part of the Atlantic lying North of 30° N., for the Eleven Days ending 8th February 1870. Price, with Book of Charts, 5*s.*
14. Quarterly Weather Report for 1871.—Parts I. to IV. 5*s.* each.
15. Report for 1871. Presented to Parliament. 10*d.*
16. Quarterly Weather Report for 1872.—Parts I. to IV. 5*s.* each.
17. Report for 1872. Presented to Parliament. 1*s.*
18. Contributions to our Knowledge of the Meteorology of the Antarctic Regions. 2*s.*
19. Quarterly Weather Report, 1873.—Parts I. to IV. 5*s.* each.
20. Charts of Meteorological Data for Square 3. Lat. 0°—10° N. Long. 20° — 30° W., and Remarks to accompany the Monthly Charts, which show the Best Routes across the Equator for each Month, &c. 20*s.*
21. Report of the Proceedings of the Meteorological Congress at Vienna. 1873. 1*s.*
22. Report for 1873. Presented to Parliament. 4*d.*
23. Report of the Proceedings of the Conference on Maritime Meteorology held in London, 1874. 2*s.*
24. Instructions in the Use of Meteorological Instruments. [Reprinted 1888.] 2*s.* 6*d.*
25. Quarterly Weather Report for 1874.—Parts I., II., and IV., 5*s.* each. Part III., 5*s.* 9*d.*
26. Report for 1874. Presented to Parliament. 6*d.*

* The Meteorological Council have given away the copies which were placed at their disposal, but the work can be purchased from the Publishers.

LIST OF PUBLICATIONS, &c.—*continued.*

No. 27. Charts of Meteorological Data for the Nine 10° Squares of the Atlantic which lie between 20° N. and 10° S., and extend from 10° to 40° W., with accompanying Remarks, ending with the Best Routes across the Equator. 24*s.*

28. Contributions to our Knowledge of the Meteorology of Japan. By Staff-Commander Thomas H. Tizard, H.M.S. *Challenger.* 1*s.*

29. Report for 1875. Presented to Parliament. 4*d.*

30. Quarterly Weather Report for 1875.—Parts I.—IV. 5*s.* each.

31. Report for 1876–7. Presented to Parliament. 3*s.* 5*d.*

*32. A Discussion of the Meteorology of the North Atlantic during August 1873, with 31 Synoptic Charts. 15*s.*

33. Quarterly Weather Report for 1876 (New Series).—Part I., 6*s.*; Parts II., III., and IV., 5*s.* each.

*34. Contributions to our Knowledge of the Meteorology of the Arctic Regions.—Vol. I.: Part I., 2*s.*; Part II., 10*s.*; Part III., 6*s.*; Part IV., 5*s.*; Part V., 6*s.*

35. Report for 1877–8. Presented to Parliament. 1*s.*

36. Report of the Proceedings of the Meteorological Congress at Rome, 1879. 1*s.* 6*d.*

37. Report on the Meteorology of Kerguelen Island. By the Rev. S. J. Perry, S.J., F.R.S. 3*s.*

38. Report for 1878–9. Presented to Parliament. 5*d.*

39. Meteorological Observations at Stations of the Second Order for the year 1878. 20*s.*

40. Aids to the Study and Forecast of Weather, by the Rev. W. Clement Ley, M.A. 1*s.*

41. Report for 1879–80. Presented to Parliament. 1*s.*

42. Report for 1880–81. Presented to Parliament. 1*s.* 2*d.*

43. Charts of Meteorological Data for the Ocean District adjacent to the Cape of Good Hope, with accompanying Remarks. Price of the Charts, 25*s.*; of the Remarks, 7*s.*

44. Report on the Gales experienced in the Ocean District adjacent to the Cape of Good Hope, between Lat. 30° and 50° S., and Long. 10° and 40° E., by Capt. H. Toynbee. 7*s.* 6*d.*

45. Meteorological Observations at Stations of the Second Order for the year 1879. 20*s.*

46. Report on the Storm of October 13–14, 1881. By Robert H. Scott, F.R.S. 1*s.* 6*d.*

47. Rainfall Tables of the British Isles for 1866–80. Compiled by G. J. Symons, F.R.S. 7*s.* 6*d.*

48. Report for 1881–2. Presented to Parliament. 1*s.*

49. Quarterly Weather Report for 1879. (New Series.) Parts I., II., and III., 6*s.* each; Part IV., 5*s.* 6*d.* Appendices and Plates. 27*s.*

50. Quarterly Weather Report for 1880. (New Series.) Parts I. and II., 6*s.* each; Part III., 4*s.*; Part IV., 6*s.* Appendices and Plates. 28*s.*

51. Hourly Readings, 1881. (New Series.) Part I., 10*s.* 6*d.*; Parts II., III., and IV., 21*s.* each.

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* The Meteorological Council have given away the copies which were placed at their disposal, but the work can be purchased from the Publishers.

LIST OF PUBLICATIONS, &c.—*continued.*

No. 52. Quarterly Weather Report for 1877. (New Series.) Part I., 10*s.*; Part II., 5*s.*; Part III., 4*s.* 6*d.*; Part IV., 6*s.* Appendices and Plates. 27*s.*

53. Meteorological Atlas of the British Isles. 5*s.* 6*d.*

54. Hourly Readings, 1882. Parts I. and II., 20*s.* each; Part III., 22*s.* 6*d.*; Part IV., 26*s.*

55. Quarterly Weather Report for 1878. (New Series.) Parts I., II., III., and IV., 6*s.* each. Appendices and Plates. 28*s.*

56. Sunshine Records of the United Kingdom for 1881. 4*s.*

57. Meteorological Observations at Stations of the Second Order for the year 1880. 34*s.* 6*d.*

58. Report for 1882–3. Presented to Parliament. 10½*d.*

59. Charts showing the Surface Temperature of the Atlantic, Indian, and Pacific Oceans. 21*s.*

60. Principles of Weather Forecasting. By the Hon. Ralph Abercromby, F.R.Met.Soc. (Second edition), 2*s.*

61. A Barometer Manual for the Use of Seamen. 1*s.* 3*d.*

62. Monthly Weather Reports for 1884. Jan., Feb., March, May —Nov., 1*s.* 6*d.* each. April (with 2 Appendices), 2*s.* 6*d.* Dec., 1*s.* 9*d.*

63. Hourly Readings, 1883. Parts I., II., and III., 21*s.* each; Part IV., 30*s.*

64. Report for 1883–4. Presented to Parliament. 1*s.* 2*d.*

65. Monthly Weather Reports for 1885. Jan. to Dec., 1*s.* 6*d.* each.

66. Meteorological Observations at Stations of the Second Order for the year 1881. 35*s.*

67. Report for 1884–5. Presented to Parliament. 4*s.* 4*d.*

68. Monthly Weather Reports for 1886. Jan. to Dec., 1*s.* 6*d.* each.

69. Meteorological Observations at Stations of the Second Order for the year 1882. 35*s.*

70. Hourly Readings, 1884. Part I., 12*s.*; Part II., 10*s.*; Part III., 10*s.* 6*d.*; Part IV., 15*s.*

71. Synchronous Weather Charts of the North Atlantic and the adjacent Continents. Aug. 1, 1882, to Sept. 3, 1883. Parts I. to IV. (33 sheets each.) 17*s.* each.

72. Report for 1885–86. Presented to Parliament. 8*d.*

73. Meteorological Observations at Stations of the Second Order for the year 1883. 30*s.*

74. Hourly Readings, 1885. Parts I. and II., 11*s.* each; Part III., 10*s.* 6*d.*; Part IV., 12*s.*

75. Report for 1886–87. Presented to Parliament. 8*d.*

76. Charts showing the Mean Barometric Pressure over the Atlantic, Indian, and Pacific Oceans. 10*s.* 6*d.* Supplemental Chart, 6*d.*

77. Monthly Weather Reports for 1887. January to April, 1*s.* 6*d.* each. May to December, in wrapper, price 12*s.*

78. Meteorological Observations at Stations of the Second Order for the year 1884. 32*s.*

79. Report for 1887–88. Presented to Parliament. 1*s.*

80. Daily Weather Charts for the period of six weeks ending June 25, 1885, to illustrate the tracks of two cyclones in the Arabian Sea. 10*s.*

LIST OF PUBLICATIONS, &c.—*continued.*

No. 81. Hourly Readings. 1886. Parts I., II., and III., 10*s.* 6*d.* each. Part IV., 12*s.* 6*d.*

82. Meteorological Observations at Stations of the Second Order for the year 1885. 31*s.*

83. Meteorological Observations at the Foreign and Colonial Stations of the Royal Engineers and Army Medical Department. 1852–1886. 23*s.*

84. Report for 1888–89. Presented to Parliament. 5½*d.*

*85. Weekly Weather Report for the year 1888. Vol. V. Second Series. 4*d.* per week. With Appendices and Monthly Supplements, priced separately.

86. Weekly Weather Report for the year 1889. Vol. VI. Second Series. 6*d.* per week. With Appendices and Monthly Supplements, priced separately.

87. Weekly Weather Report for the year 1890. Vol. VII. Third Series. 6*d.* per week. With Appendices and Monthly Supplements, priced separately.

88. Meteorological Observations at Stations of the Second Order for 1886. 25*s.*

89. Meteorological Observations made at Sanchez, Samaná Bay, St. Domingo. 1886–88. By the late W. Reid, M.D. 8*s.* 6*d.*

90. Cyclone Tracks in the South Indian Ocean. From information compiled by Dr. Meldrum, C.M.G., F.R.S. Price 7*s.*

91. Report for 1889–90. Presented to Parliament. 7½*d.*

92. Meteorological Charts of the portion of the Indian Ocean adjacent to Cape Guardafui and Ras Hafún. 6*s.*

93. Harmonic Analysis of Hourly Observations of Air Temperature and Pressure at British Observatories. (In the Press.)

94. Hourly Means of the Readings obtained from the Self-recording Instruments at the Four Observatories under the Meteorological Council, 1887. 16*s.*

95. Meteorological Observations at Stations of the Second Order. 1887. 24*s.*

96. Weekly Weather Report for the year 1891. Vol. VIII., Third Series. 6*d.* per week. With Appendices and Monthly Supplements, priced separately. Annual subscription, including Supplements and Appendices, post paid, 30*s.*

97. Hourly Means of the Readings obtained from the Self-recording Instruments at the Four Observatories under the Meteorological Council, 1888. (In the Press.)

98. Ten Years Sunshine in the British Isles (1881–90). (In the Press.)

99. Report for 1890–91. Presented to Parliament.

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* The publication of the Weekly Weather Report began in February 1878.

LIST OF PUBLICATIONS, &c.—*continued.*

NON-OFFICIAL.

No. 1. Report to the Committee on the Connexion between Strong Winds and Barometrical Differences.—By Robert H. Scott, Director of the Office. 6*d.*

*2. Report to the Committee on the Meteorology of the North Atlantic.—By Captain H. Toynbee, Marine Superintendent. 1*s.*

*3. Report to the Committee on the Use of Isobaric Curves.—By Captain H. Toynbee, Marine Superintendent. 1*s.*

4. Routes for Steamers from Aden to the Straits of Sunda and back. Translated from a Paper issued by the Royal Meteorological Institute of the Netherlands. 6*d.*

5. On the Winds, &c. of the North Atlantic along the Tracks of Steamers from the Channel to New York. Translated from a Paper issued by the Deutsche Seewarte, Hamburg. 6*d.*

6. Report of the Proceedings of the Meteorological Conference at Leipzig. 1872. 1*s.*

7. Notes on the Form of Cyclones in the Southern Indian Ocean. — By C. Meldrum, M.A., F.R.S. [Out of Print.]

8. Report on Weather Telegraphy and Storm Warnings. Presented to the Meteorological Congress at Vienna. 1873. 6*d.*

9. Report of the Permanent Committee of the Vienna Congress for 1874. 1*s.* 6*d.*

10. On the Physical Geography of that part of the Atlantic which lies between 20° N. and 10° S. and extends from 10° to 40° W. A Paper read before the British Association at Bristol, in August 1875.—By Capt. Toynbee, F.R.A.S., F.R.G.S., Marine Superintendent. 1*s.* 6*d.*

11. Report of the Permanent Committee of the Vienna Congress for 1876. With Supplement. 2*s.*

12. Reports to the Permanent Committee of the Vienna Congress on Atmospheric Electricity, Maritime Meteorology, and Weather Telegraphy, 1878. 2*s.*

13. Report of the Permanent Committee of the Vienna Congress for 1878. 6*d.*

14. Report of the International Meteorological Committee Meeting at Berne, 1880. 1*s.*

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* The Meteorological Council have given away the copies which were placed at their disposal, but the work can be purchased from the Publishers.

LIST OF PUBLICATIONS, &c.—*continued.*

No. 15. Report of the Second Meeting of the International Meteorological Committee, held at Copenhagen, August 1882. 2*s*. 6*d*.

16. Report of the Third Meeting of the International Meteorological Committee, held at Paris, September 1885. 1*s*.

17. Report of the Fourth Meeting of the International Meteorological Committee held at Zürich, September 1888. 4*d*.

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